
EX LIBRIS
G Brown Goode
Ffor hym was lefere to have at hese bedis hed
Twenty bokis I-clad in blak or red
Of Aristotle & his philoso-phie
Than robis ryche or fedele or gay sautrie
S. 1.
U.S. National Museum
S. 1.

172772

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XXXIII

NOVEMBER 1885 to APRIL 1886

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

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NATURE

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

THURSDAY, NOVEMBER 5, 1885

HYDROPHOBIA

Ὑδροφοβίαν Græci appellant: miserrimum genus morbi.

ONCE more M. Pasteur is attracting the attention of the civilised world by his brilliant investigations. The disease which he hopes to prevent and ultimately to erase from the records of human misery is happily rare, but those who have watched it know that it is one of the most terrible in its effects, and that it is incurable by any means at present known. So strange are its symptoms and its course, that it has been asserted to be no real malady but a mere result of fright and superstition.[1] But of its reality there is unhappily no room for serious question.

It never arises of itself. Like small-pox and syphilis, it is always the result of contagion, and the method and conditions of its transference from rabid dogs or other animals to man are well known. Hitherto the only chance, when a human being has been bitten by a mad dog, has been to remove or isolate or destroy the virus by suction, or ligature, or cautery. And it has been doubted whether these methods are really successful even when the disease does not manifest itself afterwards. For there is often reasonable doubt as to the nature of the disease in the biter. All vicious dogs are not "mad," and all mad dogs are not truly rabid. And when, as often happens, the dog has been at once destroyed, it is impossible to supply deficiencies of previous observation. Moreover, when bitten by a rabid dog, the sufferer may yet escape, for the teeth may only have grazed the skin, and not penetrated to the living tissues beneath, or the poisonous saliva may have been mechanically wiped off by the clothing which the teeth have pierced. As with the venom of snakes, so with the saliva of rabid dogs: it is not enough for it to be spread over the skin, for that will not absorb it, nor even to be swallowed and taken into the stomach, for there, as physiologists say, it is still "outside the body," and, before it can be absorbed, undergoes such changes by the process of digestion, as kill the germs or decompose the chemical compound. The virus must be introduced into the living tissues before it can be carried over the whole body by the channels of the lymph and blood, and reach the central nervous system, on which it exerts its characteristic poisonous action. But, when once so introduced, there is every reason to believe that the terrible effects are constant and uniform. The state of the receiver of the venom at the time may probably modify the rapidity of absorption, as is the case with stimulants and with poisonous drugs; but so far as we know there is no power in the most healthy organism by which the subtle venom, once absorbed, can be neutralised or thrown out. The methods above mentioned[1]—suction by the mouth or by cupping glasses, ligature, and caustics or the actual cautery—all aim at getting the poison out before it has been absorbed. Often they come too late, often they are impracticable or ineffectual from the first. However long the time of "incubation" may be, the interval between the reception of the virus and its spread over the body, no method of preventing the terrible result is known. The length of incubation is far longer than it is in the case of small-pox, of cow-pox, of syphilis, and other known contagions. In two-thirds of the cases collected by Prof. Bollinger, of Munich, the interval of incubation was under two months; and probably it never extends to so long a period as was formerly supposed. The length of this period makes it almost certain that we have to do, not with a mere chemical compound, as in the case of subcutaneous injection of morphia, and probably of the cobra-poison, but with a "particulate contagium," like that of small-pox and chicken-pox, with a living and growing organism, like those of relapsing fever and of anthrax.

Whatever the conclusions to which pathologists will at last be led on these points, the important fact remains that there is an interval of days or months in which the latent plague, established in the patient's body, but not yet ripe for mischief, may be attacked.

[1] So, in the last century, Sir Isaac Pennington, Regius Professor of Physic at Cambridge, and in recent times Prof. Mashka, of Prague.

[1] These are what were known to the ancients:—"Si rabiosus canis est, cucurbitulâ virus ejus extrahendum est. Deinde . . . vulnus adurendum est." Celsus de Medicinâ, lib. v. cap. xxvii. § 2.

Experience has shown that it cannot be mechanically removed by any surgical operation, nor chemically neutralised or destroyed by any drug. The only promising path of investigation is to seek for some method of forestalling the action of the virus by rendering the organism unfit for its action, as patriots have ravaged their fields and burnt their towns to save their country from an invading army.

By this method Jenner robbed small-pox of most of its terror and almost all its danger, so that where Jennerian vaccination is thoroughly carried out, as in the German army and in Ireland, small-pox is practically extinct.

Pasteur's method of dealing with hydrophobia is avowedly based on the practice of vaccination; but it is not the mere introduction of the poison in a way that makes its effects less dangerous, like the inoculation of small-pox practised in the last century. Nor is it exactly analogous to Jenner's vaccination, although that term is appropriated by Pasteur himself. For in vaccination an allied disease (or possibly small-pox itself, greatly modified by long transmission through other organisms) is inoculated. In either case the course and symptoms of cow-pox are distinct from those of the more serious disease against which it protects. But in the case of hydrophobia, as in that of "chicken-plague" and anthrax, the poison of the same disease is transmitted through a succession of "bearers" until it is so modified that it may be safely inoculated, and thus the altered virus protects from that which is unmodified.

The "bearers" chosen for these experiments were rabbits. The test of the result was made, not upon human beings but upon dogs, for M. Pasteur is a philanthropist first and a zoophilist after. Fifty dogs were inoculated with modified virus obtained from the bodies[1] of rabbits which had themselves been affected with rabies by inoculation. Would a dog thus inoculated show the ordinary symptoms of the disease? Would it, if bitten by a rabid dog, or designedly inoculated with the unmodified venom of rabies, be protected? Would it, if infected with the modified virus after such direct inoculation, still be safe from its effects? The results have, so far, proved the affirmative to each of these questions. None of the "vaccinated" dogs showed signs of the dreaded disease.

Then came two cases of human beings bitten by mad dogs who were sent up to M. Pasteur in Paris from their homes in Alsace. One of them, a grocer named Vone (? Wohn), had escaped without rupture of the skin, and was sent home with the comfortable assurance that he had never been infected with the disease. The other, a boy of nine years old, had been terribly worried on the 4th of last July; not only bitten in parts covered by his clothes but also on the hands. He was rescued covered with foam, and bleeding from no less than fourteen wounds. There was no question that the dog was mad, and in all human probability this child, Joseph Meister, was doomed to a certain and horrible death. Such was the opinion of the eminent pathologist, M. Vulpian, and he was supported in this judgment by Dr. Grancher.

Under these circumstances M. Pasteur felt himself justified in applying the means to this suffering fellow-creature, which had already proved efficacious in the case of brutes.[1]

[1] Not the marrow, as the *Times* states, but the spinal cord, *moelle épinière*.

The inoculations were made with a subcutaneous needle, began on the 7th, and were concluded on the 16th of July. "Control experiments" were made with the same injections upon rabbits, and proved that the virus was active. Moreover, since the effects of the modified virus, when introduced into an unprotected animal, are rapid and severe, and its period of incubation extremely short, the result of the attempt to rescue the child from a horrible death would soon be apparent. If he had died of hydrophobia, it would probably have been within a month. If he survived this period there was every reason to hope that he would be as much protected against its future manifestation as the dogs which had been tested before.

Joseph Meister was in perfect health at the end of August, at the end of September, and at the end of October. M. Pasteur believes that he is safe from hydrophobia for the rest of his life.

If similar cases should be followed by similar results, medical science has for the first time a method of combating a frightful and incurable disease.[2] But beyond this, by inoculating dogs, as infants should be vaccinated, they will be rendered insusceptible to rabies. Any mad dog will be destroyed, and the dogs he has bitten will escape. Thus the disease may, it is hoped, be extirpated altogether.

These, however, are but hopes; at present the whole question is *sub judice*. Other competent observers must repeat the experiments, and every result must be submitted to searching criticism. This is no slight on M. Pasteur, it is only worthy respect to his genius and his skill. For the credentials of the champion who has undertaken the task of ridding the world of this horrible plague of hydrophobia are well known.

M. Louis Pasteur won his spurs as a chemist. It was his discovery of remarkable forms of crystallisation of racemic acid which first made his name known, and which gave M. Renan the opportunity for the exquisite raillery with which the man of letters welcomed the man of science to the Academy.

In dealing with the disease of silk-worms in the south of France, Pasteur first handled a physiological problem, and his thoroughness of research, fertility of resource, and felicity in experiments ended in the best result—practical success as the result of strictly scientific investigation.

Pasteur subsequently investigated the so-called cholera of domestic fowls, and by the method of "attenuated" inoculation has succeeded in protecting them from a destructive epidemic.

His far larger and more important work on the prevention of splenic fever (*charbon* or *anthrax*), the most destructive plague among cattle, has had important and useful results. It has in all probability saved countless multitudes of sheep and oxen in France. In Algeria the results were less satisfactory, and also in Hungary. On the other hand Dr. Roy found the method valuable in La

[1] "La mort de cet enfant paraissant inévitable, je me décidai, non sans de vives et cruelles inquiétudes, on doit bien le penser, à tenter sur Joseph Meister, la méthode qui m'avait constamment réussi chez les chiens" (*Comptes Rendus* de l'Académie des Sciences, October 26, 1885).

[2] One other patient, a shepherd boy, who was bitten while gallantly attacking a rabid dog, has been inoculated, and the result is to be seen.

Plata. The results of Pasteur's experiments on "pig-typhoid" have also been criticised, and not without reason, by Prof. Klein. It is foolish for newspaper correspondents to attribute hesitation in accepting scientific results to jealousy. Much scrutiny will be necessary. Adverse criticism will be welcomed. M. Pasteur's fame stands in no need of artificial protection.

His past achievements are great: his last attempt was prudent in conception, and carried out with untiring zeal and admirable care. It deserves to succeed. If so, he will again receive the applause of the civilised world; if not, he will have the sympathy and respect of every pathologist.

It is melancholy to reflect that it would be practically impossible for any duly qualified man in England to repeat, to confirm, or to correct his results. We must wait till a wiser and more humane public opinion repeals the present restrictions upon investigations like Pasteur's.

TOPINARD'S "GENERAL ANTHROPOLOGY"

Éléments d'Anthropologie générale. Par le Dr. Paul Topinard. (Paris: A. Delahaye et É. Lecrosnier, 1885.)

THE study of anthropology has been pursued, especially of late years, with great zeal by many leading *savants*, both in the Old and New World, and many valuable contributions to our knowledge have been made in all departments included under its extensive range. This is more particularly the case with respect to that part of the subject which deals with the anatomical characters of the human body. Until this branch of anthropology was so vigorously and successfully studied by Broca, complete ignorance of many fundamental questions prevailed. The direct result of the work of that great anthropologist was immense, while the indirect result due to the incentive which he gave to the study of anthropology generally cannot be over-estimated, but may be inferred from the numerous societies devoted to its study which have rapidly sprung up in various countries. Broca must be considered the great pioneer of modern anthropology, but his untimely death left his work by no means complete, and many extensive fields remained almost untrodden by the foot of the investigator. By the accumulated observations of his followers these deficiencies have been in great part made good, and the time had arrived when it was possible to form generalisations from sufficient data, and when a comprehensive work embracing the whole subject was urgently needed. For the production of such a work no one more highly fitted could be found than Prof. Paul Topinard, trained at the feet of the great master himself, possessed of an extensive knowledge of his subject, and intimately acquainted, by personal visits to the chief centres of anthropological research, with the methods employed by his contemporaries.

The volume before us deals with the elements of general anthropology, and is the first part of Prof. Topinard's contemplated work, which, when completed, will consist of three parts, the second and third parts being devoted to special anthropology and a general survey of the whole subject, concluding with man's place in time, his origin and future.

Prof. Topinard begins by giving an historical account of the origin and development of anthropology, and claims that it is not a new science developed during the latter half of the present century, but that it has, during the last twenty years, attained its adult age and gained its independence.

He divides its history into different periods: (1) from antiquity till the year 1230, the date of the birth of human anatomy; (2) from 1230–1800, when anthropology asserted itself under the influence of Buffon, Blumenbach, Sœmmering, and White; (3) from 1800–1860, during which time three important events occurred that materially assisted its development—viz. the founding of the Society of Anthropology of Paris, the demonstration of the high antiquity of man, and the promulgation of the doctrine of evolution by Darwin. To these a 4th and more recent period is added—viz. that during which Broca's personal influence, aided by the advance of natural sciences, gave great impulse to anthropology. Each of these periods is considered in detail, and many matters of much interest are discussed.

Chapters VII. and VIII. are devoted to generalities including under this a definition of anthropology, its object and the subjects which it embraces. Anthropology is defined as the branch of natural history which treats of man and of the human race. It includes two distinct departments of study—viz. anthropology proper and ethnography; the former treating of the human species and its varieties or races from a purely animal aspect, and therefore essentially anatomical and physiological in its nature; the latter dealing with people and intimately connected with sociology. For the study of anthropology proper, anatomical and zoological knowledge is essential; but such knowledge is not necessary for the study of ethnography, as questions of race are excluded from it. Having discussed the various essential and accessory anthropological sciences, the place of anthropology in science, the meaning of the terms, "characters," "types," "races," "people," "nationalities," &c., he proceeds in the ninth chapter to consider general methods of anthropological research. The different kinds of physical characters and their study are first discussed. These are of three kinds—morphological and anatomical, descriptive and anthropometrical, and finally zoological and anthropological. After a few remarks on anthropometry, and on the comparison of measurement on the skeleton and on the living, which are stated to be not generally directly comparable, an observation which entirely agrees with our own experience, the subject of craniology is discussed, the various points on the skull to which it has been found convenient to give technical names are defined, and derivations and meanings of various terms such as "brachycephalic," &c., applied to skulls to express their form, are explained. In discussing the merits of instruments for measuring the skull, their simplicity is insisted upon. The elaborate instruments used in Germany, and by those who follow the German school (of which happily there are few) are very justly condemned. Broca's *compas d'épaisseur* and the *compas glissière* are figured and recommended. These are certainly simple, but, after considerable experience in their use, we rather take exception to the former, as not being very exact, on account of the measurements being read off on a scale reduced to one-half the actual length of the measurement. This may be avoided by using Flower's craniometer, which has the further advantage that it combines both Broca's instruments in one.

The consideration of the characters used in the classification of races is begun in the tenth chapter. The first of these discussed is the hair. A very concise *résumé* is given of the anatomy of the hair follicles and the development of hair, its distribution, size and form in various races. Six types of hair are described, and good illustrations of each are given. The characters of the nose are next considered. The anatomy of the soft and hard parts forming it are described and illustrated by means of beautifully executed woodcuts. The nasal indices of the skulls of various races are tabulated, and show clearly the value of the form of the nasal opening as a race character. In the living subject eight forms of nose are recognised and figured. All of these are easily distinguishable, and we would suggest the desirability of having cards with these forms printed separately for the use of travellers as a means of obtaining much more accurate information than we now obtain from descriptions of this part of the face, which are very frequently extremely vague and unsatisfactory. If furnished with such a card the traveller would be able to record the form of the nose by simply noting the number of the type to which the nose of each person examined corresponds. The table of nasal indices in the living will prove useful for comparison with those of the bony parts.

The colour of the skin, eyes, and hair are dealt with in the following chapter in the same systematic manner as the previous characters treated of. Prof. Topinard concludes that there are only two types—the blond and the dark; that the other so-called types—yellow and red in particular, can only in a very minor degree serve to distinguish races, and that colour as a rule is an uncertain character, liable to alter in individuals, and difficult to determine and express. As a concession, however, to the general practice, he gives a table of classification of races by their colour under the three denominations—white, yellow, and black.

The cephalic index, unlike colour, is described as a character of prime importance in the classification of races, since it indicates the general form of that portion of the skull which contains the brain. Before the cephalic index can have the same value in all cases, it is absolutely necessary that there should be complete uniformity in the manner of measuring the length and breadth of the cranium, the two measurements from which it is deduced. Unfortunately this has not hitherto been the case. French anthropologists have uniformly measured the cranial length as that between the most prominent points of the glabella in front and the occipital behind in the mesial line, and the breadth between the most widely distant points on the same plane of the parietal or squamosal bones at right angles to the length. This we contend is the only satisfactory method of measuring these diameters. In England the anterior point of length has been taken until recently from the ophryon, while in Germany the length is measured from the glabella to a point on a line perpendicular to the most posterior part of the occiput at right angles to a plane adopted by the Frankfort agreement as the horizontal of the skull. The breadth likewise has been differently measured on the parietal bones or on the squamosals. Fortunately the methods of measuring these diameters is uniform now in France, England, and most other countries, except Germany. Skulls are classified according to their cephalic indices into three groups—dolichocephalic, mesaticephalic, and brachycephalic; but the limits assigned to each group by different anthropologists vary very considerably, as the tables in Prof. Topinard's work will show. The limits assigned by the author to each group are such as to commend his classification generally. He subdivides the dolichocephalic and brachycephalic groups—the former into dolichocephalic and sub-dolichocephalic, and the latter into sub-brachycephalic and supra-brachycephalic, and gives these subdivisions and the mesaticephalic group each a limit of five units. Thus we have practically five groups—viz. dolichocephalic, where the index is between 65 and 69 inclusive; sub-dolichocephalic, 70-74 inclusive; mesaticephalic, 75-79 inclusive; sub-brachycephalic, 80-84 inclusive; and supra-brachycephalic, 85-89 inclusive. Skulls with indices below or above the extreme limits of these groups are termed ultra-dolichocephalic and ultra-brachycephalic respectively. This classification and the limits of each class agree with the ideas on the subject most generally entertained, and we would earnestly urge their acceptance. In one small point the nomenclature might be improved by the insertion of the word "sus," or in English supra, to distinguish the higher group of the dolichocephalic class (if its omission is not an overlook in the correction of the proof sheets of the work) so as to make the nomenclature of this subdivision correspond to that of the higher division of the brachycephalic class—"sus-brachycephalic." The tables of cephalic indices of skulls and of the heads of various races will prove extremely useful for reference.

Chapters XIII. and XIV. are devoted to stature. The development of the skeleton and its variations in height are first considered; then, secondly, the stature of the inhabitants of different countries. These chapters contain much information collected together from many sources.

The two following chapters treat of the weight and size of the brain at different ages, and in different persons and races, its relation to the weight and stature of the body, and other questions of much interest regarding it, which will well repay perusal by those interested in neurology as well as anthropologists.

The next chapter (XVII.), on the cubage of the cranial cavity, will be read with much interest, being a subject to which Prof. Topinard has given special attention. It reveals the great diversity of opinion which still exists regarding the best method of measuring the capacity of the encephalon. A system of cubage easy of application which would yield constant results in the hands of different operators, and at the same time indicate the actual size of the encephalon would probably be readily accepted by most anthropologists. Broca's system, which is perhaps the one most generally used, gives constant results, but is somewhat complicated and does not indicate the absolute capacity. Even with its faults Prof. Topinard considers it is the best method we have at present, he however contemplates some modifications of it which will simplify it and make it more satisfactory. This being the case it is needless to criticise the chapter further at present, but pass on to the next subject—viz. the skull itself, its measurements, and its characters—a most important part of the work, occupying ten chapters. In the limited space at our disposal it is impossible to enter into an examination of this part of the work adequate to its importance. When it is studied in conjunction with Broca's "Instructions Craniologiques," the results of more extended researches on a larger amount of material and more matured views are observable. Many measurements recommended by Broca in his work published in 1876 were abandoned by him before his death or delegated to a place of secondary importance. If any exception can be taken to this part of Prof. Topinard's work it is that it is too much an exposition of Broca's views to the exclusion of those of the author. Broca's methods are strictly adhered to in some instances where more independent consideration with knowledge acquired since his death might have resulted in a modification of the opinions expressed regarding them.

After discussing the general development of the skull and the relations between the configuration of the exterior of the cranium and of the brain, the measurements of the skull are considered. The skull is divided into a cranial and a facial portion, and the measurements of each are detailed and their relative importance pointed out. The measurements of the cranial portion recommended and the method of making them are those usually adopted; those of the facial portion, however, will give rise to some discussion. The ophryon of Broca is shown to be somewhat unsatisfactory in its determination; Prof. Topinard with much pains shows that a better point is the supercilliary point, which corresponds to the most anterior part of the brain, and is situated in the mesial line immediately above the glabella on the level of a line drawn horizontally above the supercilliary ridges. It seems to us absurd to give a second name to a point so closely corresponding to the ophryon, and we would consequently recommend that the definition of the "point intersourcilier" should be considered only as an amendment of Broca's definition of the ophryon. Natural or pathological and artificial deformities of the cranium and their effect on the brain are very fully and ably considered and illustrated by woodcuts. The vexed question of the proper plane of orientation of the skull receives due consideration, and the condylo-alveolar plane, which was determined by Broca after much research, is recommended as the best and simplest. Of all the positions proposed we also consider this the best, and hope to see it universally adopted. From the skull in this position the prognathism of the several parts of the face is easily determined by means of a vertical equerry and a small triangular one. Prof. Topinard finds that the prognathism which is most important in distinguishing race characters is the alveolo-subspinal, and he figures five different typical modifications of the form of the face in this region. In his remarks on Prof. Flower's method of indicating prognathism we think Prof. Topinard has misunderstood the object of selecting the basio-nasial line as the standard of comparison. This line is specially chosen as being as nearly as possible the primary line of development of the skull, and because it is more constant than perhaps any other measurement of the skull. By means of the indices measurements from the basion to the alveolar point, or to the sub-nasal spine, with the basio-nasial radius, the relative prominence of the various parts of the face can be easily expressed, and compared in different races. Though Prof. Topinard's method is perhaps the more strictly correct one, that of Prof. Flower has the advantage in being the more practical, from its being simpler.

We may here remark regarding certain measurements recommended by Prof. Topinard between the occipital point and various points on the face, with the object of indicating its profile outline, that we consider it would be preferable if the basion was selected as the starting point for them, instead of the occipital point, on account of the former being much more fixed than the latter. The relative proportion which these radii bear to one another according as the occipital point is situated high up or low down on the occipital bone is very great; indeed so much so as to render their indices almost valueless for purposes of comparison. This fact has probably been overlooked by Prof. Topinard in his desire to obtain a method of measuring the skull, which would be applicable also to the head of the living person.

In treating of the facial index, Prof. Topinard adheres to Broca's method of measuring the length of the face from the ophryon. This point we consider very unsatisfactory, as two observers will seldom place it at exactly the same spot. The facial height is best measured from the nasion, and we prefer the facial index of Kollmann to that of Broca. The lines of contour of the face are valuable in demonstrating the relative proportions of the upper and lower parts of the face to the maximum or bizygomatic width, and supplement the facial indices.

The number of measurements of the mandible have been much reduced by Prof. Topinard, and it is studied more in connection with the skull, as it should be, than as a mere isolated bone.

Chapter XXVII. contains a useful *résumé* of the various systems of measurements of the skull employed in Germany and England, a table of the measurements considered by the author to be of prime importance, and a more extended list to be used in making more minute researches. The method of orientation of the skull and of making measurements in relation thereto, advocated by the Frankfort agreement, is very justly condemned, but in an unoffensive and truly scientific spirit.

The last chapters of the work treat of the characters of the trunk and extremities, and contain valuable tables of the proportions of these parts of the body in different races. Throughout the work the characters in the living subject are carefully considered side by side with those of the skeleton, which is of great practical value not only to the anthropologist alone but to artists and others wishing to make themselves acquainted with the subject of human morphology.

The work concludes with a carefully drawn up table of directions and measurements of the body for the use of travellers, which will doubtless prove very valuable, and we hope will be the means of bringing us more exact information regarding the physical characters of many races yet imperfectly described.

The work is one in every respect worthy of the author, and cannot fail of being highly appreciated by anthropologists everywhere. We hope the time may not be far distant when the other volumes promised will be in our hands.

J. G. GARSON

OUR BOOK SHELF

Our Insect Enemies. By Theodore Wood. 220 pp. small 8vo. (London: Society for Promoting Christian Knowledge, 1885.)

We have read the book through without discovering anything (save in some questions that may be regarded as essentially controversial) to find fault with. The illustrations are not numerous, but to the point, and, although somewhat coarse, are better selected than is sometimes the case in books of this nature. There are fourteen chapters in all, of which four are not inappropriately devoted to Aphides. The important subject indicated by the title is treated calmly, and apparently with a view to discourage the undoubtedly ill-effects produced by panic-mongers in economic entomology. The first (or "introductory") chapter is well considered and well reasoned.

Some Account of the "Palan Byoo," or "Teindoung Bo," (Paraponyx oryzalis), a Lepidopterous Insect-pest of the Rice-Plant in Burma. By J. Wood-Mason, Officiating Superintendent, Calcutta Museum. (Calcutta, 1885.)

A pamphlet of 12 pp., with a plate, concerning a lepidopterous larva that damages, but does not, as a rule, appear to kill the rice-plant. It is more useful as a contribution to pure biology than to economic entomology. It describes one of the few Lepidopterous larvæ that breathe mainly by gills (or branchiæ), and from this cause is considered an ally of our common little aquatic moth known as *Paraponyx stratiotalis.* The vernacular names by which the insect is known are not such as to be readily remembered by "foreigners;" yet it might have been better had the author not applied a scientific name based solely on larvæ and habits. All babies are supposed to be very much alike, save to the fond parents of each in particular.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Krakatão

Although I have not yet had the good fortune of reading Dr. Verbeek's "Krakatão," yet in the review published in Nature of October 22 (p. 601) there are one or two points I would like to draw attention to. In speaking of the earthquake of September, 1880, we are told that it may have facilitated the entrance of water by the Sunda fissure. If this were so, it certainly seems a strange thing that no less than three years should be necessary to heat the water before the explosion took place. I think that at present few geologists believe in water gaining access to the magma by fissures while we neglect percolation through porous rocks. It seems to me that the above earthquake was the result of rupture and extension of the magma-filled fissure towards the surface, in consequence of which the final outburst was put off for a short time by increasing the space for, and so lowering the tension of, the magma-filled fissure. By a careful study of the products of many volcanoes I have shown how the magma gradually dissolves or takes up within it water from the surrounding rocks, and as this is a slow process, the longer a volcano remains inactive, other things being equal, the more violent will be the subsequent eruption and the more vitreous will be the pumice owing to the rapid cooling of the magma froth in consequence of the large absorption of heat in converting the dissolved water into the gaseous state of steam, in the same way that the temperature of seltzer water falls on allowing the gas to escape on removal of the cork. The above earthquake has its parallels in A.D. 63 at Vesuvius, those of 1536 and 1537 at Monte Nuovo, and in the late Ischian shocks.

The thickness of ejected materials is certainly gigantic, for the maximum thickness of the Plinian eruption at Vesuvius was under 10 metres, or just one-sixth that of Kratakão.

There is reference made to round concretions called "Krakatão marbles" that are met with amongst the ejectamenta, as being things so far unobserved. Of course, it is not possible to judge clearly from the description, but I have little doubt that they may be similar to those met with in the marl-like tufa of Ischia and others, commonly found amongst the ejectamenta of Monte Nuovo, which at the latter locality are fossiliferous. They are simply concretions in a marine resorted tufa.

The cooling of the atmosphere, referred to, at Batavia and elsewhere at a moderate distance around the volcano, might be explained by the vortex inrush of air towards the vapour column. Observations of wind direction would be interesting as settling this point.

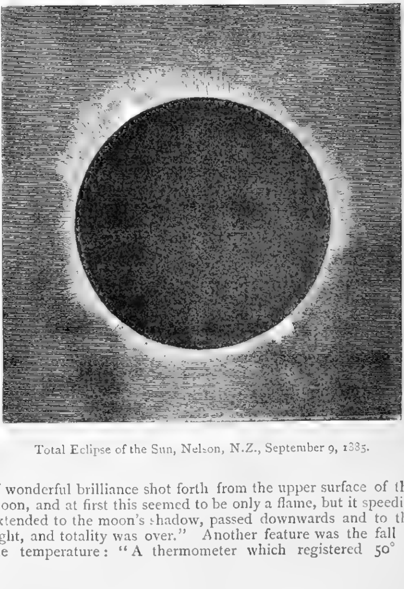
Another question of interest that was raised is the cause of non-correspondence of one part of the earth with another in seismic or volcanic activity. If we suppose a volcano to be supplied with magma by ramifications from large extensions of fluid rock within our globe, the gradual absorption of water by one of these ramifications, and the consequent increase in its tension may be quite independent of another ramification not far off, yet perhaps more or less favourably placed in relation to porous strata and superincumbent pressure and the necessary results.

I have drawn attention to these few points not with any intention to undervalue the report, which has all the characters of being one of the most important additions to the vulcanological literature of the nineteenth century, but simply to prevent certain unsound theories from becoming current.

Naples, October 26 H. J. Johnston-Lavis

The Recent Total Eclipse of the Sun

It may be interesting to your readers to supplement the description given in Nature, vol. xxxii. p. 631, with the following notes which I have just received from a friend who observed the eclipse at Nelson, N.Z.: "As the period of totality passed away, a bright point of light as from a diamond



Total Eclipse of the Sun, Nelson, N.Z., September 9, 1885.

of wonderful brilliance shot forth from the upper surface of the moon, and at first this seemed to be only a flame, but it speedily extended to the moon's shadow, passed downwards and to the right, and totality was over." Another feature was the fall in the temperature: "A thermometer which registered 50° at seven o'clock, stood at 30° immediately after totality; the keen breeze which was blowing before the sun was shadowed died completely away at the time of totality." I inclose a photograph which clearly shows the protuberances noticed by all the observers. KILLINGWORTH HEDGES

Westminster, October 30

An Earthquake Invention

THE object I had in view in my former communication to NATURE (vol. xxxii. p. 213) on this subject, has been attained, as the following quotations from Prof. Milne's letter in NATURE (p. 573) show: "I have no desire to claim the authorship of the aseismatic joint;" and again, "I am as yet in the dark as to who was the first inventor of the aseismatic joint."

Well, I can enlighten him, and I claim the invention for Mr. David Stevenson, whose paper describing it was read before the Royal Scottish Society of Arts in 1868, and published in their *Transactions;* whose firm designed, superintended the construction of, tested and sent out to Japan seven lighthouse apparatus, carried on tables 8 feet in diameter, fitted with this contrivance. Further Messrs. Stevenson designed two lighthouse *buildings,* iron towers 29 feet in diameter at the base and 46 feet in height, with an aseismatic joint *at their base,* which were constructed and *erected* in the work-yard of the contractors in Edinburgh, and finally, in 1869, shipped to Japan, but unfortunately they never reached their destination, as the vessel went down on the voyage out.

There are three points in Prof. Milne's letter on which I wish to make a few remarks. The first is to give the explanation Prof. Milne asks as to the part the late Mr. Mallet took in the invention of the aseismatic joint which I may observe Mr. Mallet never claimed for himself. Mr. Stevenson consulted with Mr. Mallet as to what was the exact *mécanique* of an earthquake shock, and how he thought it would affect the delicate apparatus usually placed in a lighthouse. This information Mr. Mallet furnished, but so far from suggesting a ball and plate joint, he expressed a fear that the superstructure, if placed on balls as proposed by Mr. Stevenson, would be thrown down, and in a letter dated March 14, 1868, acknowledging a copy of the *Scotsman* newspaper, containing a notice of Mr. Stevenson's paper, he says that if the balls and plates proposed are confined to the apparatus in the light-room, he "would augur much more favourably of the result being satisfactory," but that his "own notion for Japan or other shaky places would be to make all the towers rather of timber or of boiler plate work." This, I think, should put Prof. Milne's mind at rest on this point.

The second point is with reference to ball and plate seismographs. I never described a seismograph, but my brother did, in 1883, in NATURE, vol. xxviii. p. 117, though, so far from claiming the *idea* as original, he says: "The idea of the instrument I propose was suggested to me by the aseismatic arrangement designed by my father, Mr. David Stevenson, for averting damage to buildings and lighthouse apparatus in countries subject to earthquakes."

I entirely agree with Prof. Milne that the joint employed in ball and plate seismographs, lamp tables in Japanese lighthouses, model houses, and the Professor's own dwelling-house, all "involve the same principles, and they only differ in their dimensions," and my point is that Mr. David Stevenson was not only the original inventor of this contrivance, but, what is of far more importance, suggested and carried into practice *the* only known method of mitigating the effects of earthquake-shocks on buildings, and the astatic house of which Prof. Milne reported such good results to the British Association of 1885, which is described in NATURE, vol. xxxii. p. 527, as being "rested at each of its piers upon a handful of cast-iron shot each a quarter of an inch in diameter" placed "between flat iron plates," is obviously merely a modification of the same principle.

The third point is as to the success of the aseismatic joint. It does seem a little curious that Prof. Milne, in the *Transactions,* British Association of 1884, when he appeared to me and to others to claim the invention for himself, thought it perfection, though now he appears to have changed his mind. I do not think, however, it affects the question at issue, whether the aseismatic joint is a success or not; but that it is a success will be seen from Prof. Milne's own reports in the *Transactions* of the British Association, and from the following information which was supplied by Mr. Simpkin in 1884, who had just returned from Japan, where he was engaged in the lighthouse service. At Isuragisaki and Kashmasaki lighthouses the aseismatic tables were firmly strutted with timber to prevent any motion, as inconvenience was felt from the oscillations of the table when winding up the machine, the steadying screws sent out with the apparatus for the purpose of temporarily doing so having for some reason not been put in at these stations. These two are the only lighthouses at which any damage has been done by earthquake, while those stations at which the tables are in operation have never suffered at all, although they have been repeatedly subjected to shocks: but for full particulars as to this see NATURE, vol. xxx. p. 193, and vol. xxxii. p. 316.

Prof. Milne excuses himself on the ground that he was 10,000 miles away from a library and never saw Mr. Stevenson's paper, but surely NATURE finds its way out to Japan, and this subject has been referred to in your columns frequently; it was also discussed in 1876 before the Institution of Civil Engineers, and an account of it was published in their *Transactions;* but, after all, the apparatus was actually at work in Japan where he was living. D. A. STEVENSON

84, George Street, Edinburgh, October 19

The Mithun

I WAS glad to see in NATURE of July 16 (p. 243) that Mr. W. F. Blanford had drawn attention to the extraordinary mistake made by Dr. Kuhn in considering the gayal and gaur specifically identical, and their differences as due to domestication. If this latter were true we should see endless intermediate forms instead of two invariably distinct. To those who know them in their habitat the confusion must seem extraordinary, even though both are here called "Mithun." The gayal (*B. frontalis,* v. *gavæus*) is known (domestic only) all through these hills, and not in the plains; is pied black and white, with pink muzzle, white legs, and the tips of the horns point *outwards.* The gaur (*B. gaurus,* v. *cavifrons*) is only known wild, in the hills and also plains, never pied, has white legs, and the tips of adult horns invariably point *inwards.* The gayal domestic, and never known wild; the gaur wild, and never known domestic; and they do not cross. I have known both here now many years, and had good opportunities of observing and contrasting them. I have had a fine bull gaur feeding along beside me at twenty yards in short grass for over quarter of an hour, as I sat motionless in my Rob Roy canoe, an enormous Dontal (tusker) elephant at the same distance off on the opposite bank; each occasionally left off to sniff me, but resumed again, taking me, in brown-grey costume and grey-coloured canoe, for a snag in midstream (which stream was deep and stagnant). It is not always easy or possible to point out to such a man as Dr. Kuhn that the study of the "dry bones" of an animal is really but half the battle in comparing it with its allies. The study of specific distinctions should include the whole animal, alive as well as dead.

But the clearest proof that these two distinct forms are not due to domestication is that, instead of endless intermediate forms, we find absolutely none. S. E. PEAL

Sibsagar, Asam, September 26

On the Behaviour of Stretched India-rubber when Heated

I SHOULD like to make the following remarks with reference to the letter of Mr. H. G. Madan which appeared in the last number of NATURE:—

(*a*) Though the fact that india-rubber becomes *hot* when *stretched* might be, and no doubt is to be, *partly* attributed to molecular friction, we cannot thus account for the *cooling* which resulted from *contraction* in the experiments of Joule and Sir William Thomson.

(*b*) Text-books as a rule are not, I am afraid, sufficiently explicit as to whether the stretched india-rubber is contracted in *volume* when heated, or only in *length.* Thermodynamic theory does not require, in order that longitudinal pull should produce rise of temperature, that the *volume* should be diminished when the temperature is raised, and the results of Joule's experiments are in reasonable accord with theory.

(*c*) The real state of things seems to be that the effect of heating a stretched piece of india-rubber is to *lengthen* it if the tension is *small,* and to *shorten* it if the tension is large (Hr. Schmulewitsch, *Vierteljahrschrift der Naturforsch. Gesellschaft, Zürich,* xi. 202); thus, for a certain tension there will be neither elongation nor contraction, and my own experiments on the effects of stress on the physical properties of matter lead me to infer that the critical tension will be lower the higher the temperature. HERBERT TOMLINSON

King's College, Strand, October 31

The Resting Position of Oysters

As your correspondent, Mr. J. T. Cunningham, expresses a doubt as to the evidence on which the current belief of conchologists is founded that oysters rest on the convex valve, I beg to inclose a cluster of three, brought to me among others from Torbay this morning. They are all attached by their convex valves, and confirm the descriptions of Messrs. Woodward, Jeffreys, and Huxley.

Mr. Cunningham's Sertularia and Thuiaria go to prove that he has seen oysters from the Firth of Forth that rested on their flat valves. This is easily accounted for. Solitary, unattached oysters, resting on the sea-bottom, would easily, from their peculiar form, be turned over by wave-currents (if exposed to them); or they might fall on their flat valves when thrown overboard by dredges as too young for market. In either case, once overturned, they would be powerless to regain their natural position.

With regard to the Pectens, Mr. Cunningham does not specify the species found covered, as to the convex valves, with Balanus, &c. In two such common sorts as *P. maximus* and *P. opercularis*, we find in the one the under-valve more convex, in the other the upper valve. In each case the mollusk rests on the same valve. ARTHUR R. HUNT

Torquay, October 27

Salmo salar and S. ferox in Tasmania

In your issue of October 29 is a communication from Mr. Saville Kent, in which he "concludes that no true salmon has yet been established in the lakes and rivers of Tasmania. The fish of large size which abound in the great lakes and other large sheets of water are really essentially the same as the great lake trout, *Salmo ferox*, of Great Britain."

Respecting the salmon, although very possibly Mr. Kent has not yet seen a true one in Tasmania, such does not absolutely prove their absence. In the *Field* of last May I drew attention to an undoubted salmon smolt, 9 inches long, which was sent home from Tasmania by Mr. Robins, on January 3, 1880, and is now in the national collection.

As regards the great lake trout, I observed in the *Proceedings* of the Zoological Society, January 15, 1884, that the original stock of British fresh-water trout from which ova were procured to send to Tasmania, were solely obtained in Hampshire and Buckinghamshire, localities where the great lake trout is not found, *unless it is merely a variety of the brook trout.*

The late Mr. W. Arthur, whose recent death at Dunedin will prove an irreparable loss respecting these investigations, sent me two specimens in ice in July 1883. One was a male, 32½ inches long, the other a female, one inch less. I remarked that "these two beautiful specimens of trout are so exceedingly similar to so-called lake trout, that any ichthyologist who believed in the numerous species of this fish, and was unaware from whence they came, would undoubtedly term them *Salmo ferox*."

Whether Mr. Saville Kent in the note in question considers the great lake trout, *S. ferox*, a distinct species from the brook trout, *S. fario*, seems left to the reader to surmise. Should he be correct in his identification (as I believe him to be), then the great lake trout has been raised from the eggs of the small brook trout, showing it to be merely a variety which, under favourable conditions, will attain to a large size. FRANCIS DAY

Cheltenham, October 30

A Right-footed Parrot

If my memory does not deceive me, Mr. Romanes asked some months ago for an account of any peculiarities shown by parrots, in which case you may be able to find a corner for the following incident:—

Last Sunday I gave our parrot—an ordinary grey bird—the hardest walnut I could find, as when busy cracking the shell she is less noisy. After struggling for a long time in vain, at first on the perch and then on the bottom of the cage, holding the walnut as usual with the right foot, she changed feet, whether because the right foot was tired or not I cannot say; but now utterly failed to make the walnut reach her beak. Time after time the walnut was raised above the bird's head, rather over the neck. At the same time she was unable to stand steady, but fell over and rested on her right wing. After about a dozen fruitless attempts, and by the time every one in the room was shaking with laughter, she flung the walnut down with a shriek and returned to her perch. C. V. BOYS

The New British Myzostoma

SINCE recording the discovery of an encysting *Myzostoma* on the Comatulæ of Milford Haven (NATURE, August 27, p. 391) I have examined a large number of other examples of *Antedon rosacea* from different British localities; and I have found *Myzostoma*-cysts or other modifications of the pinnule-joints on individuals from Torquay, Cumbræ, Arran, and Oban, while in one or two cases the arm-joints are also affected. Prof. A. C. Haddon has kindly sent me some Comatulæ which he dredged last summer in Berehaven, County Cork, and in Dalkey Sound, County Dublin, and I have found slightly malformed pinnules in one individual from each locality, though there are no traces of definite cysts. It is clear, however, from what has been said above, that this encysting *Myzostoma* has a tolerably wide distribution in the British area; and I shall be very glad to hear of its discovery on Comatulæ from other localities than those which I have mentioned.

The cysts are fairly conspicuous on the Cumbræ specimens (dredged by Mr. Sladen), though nothing like the size of those which occur on the Crinoids of more tropical seas; and I suppose that this is the cause of their having so long escaped the notice of the many naturalists who have dredged at this locality. Now, however, that attention has been directed to them, it is quite possible that they may be discovered at Roscoff and at various localities in the Mediterranean, where *Antedon rosacea* is equally abundant. P. HERBERT CARPENTER

Eton College, October 31

Tertiary Rainbows

THE following extract from my journal may be of interest with regard to the subject of "Tertiary Rainbows":—

"May 5, 1885.—Extraordinary display of rainbows at 4.30 p.m. on Grand Trunk Railway between Kingston and Montreal. *Six* bows in all were seen. The primary was flanked on the inside by four bows quite near, and on the outside at some distance by a fifth."

The bows were all quite distinct, but of course of decreasing brightness in passing from the primary inward. They were noticed by several persons besides myself.

W. L. GOODWIN

Queen's University, Kingston, Ontario, October 15

"Furculum" or "Furcula"

DR. SCLATER in his letter to NATURE (vol. xxxii. p. 466) calls attention to a very interesting point in regard to the use of the word *furculum*, asking, as he does so, for its authority. Not only are the eminent anatomists—Balfour, Huxley, and Rolleston—mentioned by him, authorities for it, but the majority of anatomical writers, both of the Continent and Great Britain; they having also lent their influence, through custom, to the introduction of this word. In this country the same holds true, and the use of the term *furculum* for *furcula* receives the support of such high authority as Marsh ("Odontornithes," p. 58, Fig. 14*f.*) and many others.

Dr. Sclater further states that he has failed to find its use sanctioned by any dictionary. For the large dictionaries of the language this no doubt is true, but in quite a number of works upon anatomy that present us with a "glossary of terms," we find the word *furculum* given, and not *furcula*, as, for instance, see "Elements of Zoology," by M. Harbison, Head Master, Model School, Newtownards, and "Handbook of Vertebrate Dissection," Part II., by Martin and Moole. More than this, *furculum* is the only word given in certain scientific dictionaries, as Dunman's "Glossary of Scientific Terms," London, 1878, and published by D. Appleton and Co., New York, 1879.

I find myself also in the same category, deserving the censure of your correspondent, and agree with him entirely in the incorrect use of the word *furculum* for *furcula*, or still more properly

as he suggests, though perhaps less convenient term, *os furculatorium*.
R. W. SHUFELDT
Fort Wingate, New Mexico, October 8

Metric or English Measures?

WOULD any of your readers have the great kindness to give me their opinion on the following question?

In writing a school-book in which such branches of physics as dynamics and heat are to be treated in a very elementary but exact way, would it be best to use the metric system or the English system of weights and measures?

Personally, I am strongly inclined to take the former course; it seems to me that as soon as a boy's scientific education begins he should make acquaintance with the units of measurement now generally adopted by scientific men throughout the world.
E. R. P.

CHARLES ROBIN

ON the 6th of last month died in Josseron (Department l'Ain) Charles Robin, sixty-four years old. He was one of the few men in Europe who may be justly considered the founders of modern histology. Although some of his views, as, for instance, on the formation of cells out of a blastema, are now only of historical interest, there remain a considerable number of valuable facts which he has contributed to histology, anatomy, and zoology. A chair of General Anatomy was created for him in 1862 in the Paris Faculty of Medicine, and here he always collected round him a number of ardent students who, under his direction and imbued with his ideas, did excellent work in histology. He was, in fact, until a few years back (until Ranvier) the only exponent of and original worker in histology in France. There is hardly a chapter in this science to which he has not largely contributed. His chief works are "The Natural History of Vegetable Parasites in Man and Animals"; "On the Tissues and Secretions"; and his many articles in the "Dictionnaire Encyclopédique des Sciences Médicales."

THE LIVERPOOL INTERNATIONAL EXHIBITION

THE credit of the inception of the idea of the practicability of carrying on an International Exhibition at Liverpool appears to be due to Alderman David Radcliffe, the present Mayor of the City, who laid it before Lord Derby, who at once became the first guarantor of a fund which now exceeds 60,000*l*. The support this movement has now secured in England and on the Continent renders its success assured.

It is a matter of surprise that no International Exhibition has ever yet taken place in the North of England, when the fact is remembered, commented on by Lord Derby at the last annual banquet given to him by the Mayor of Liverpool, that the inhabitants of that City and the district lying within a radius of fifty miles of it are as numerous as those of the City of London, and the greater London, which lies within a radius of fifty miles of St. Paul's. The value of exhibitions it is difficult to over-estimate. Visitors however unintelligent must of necessity learn something of the processes and methods carried out by their countrymen in the arts and manufactures, while the exhibitors increase their technical grasp, and get their thoughts removed from stereotyped grooves by the inspection of products from countries where workmen obtain so much larger a share of technical education, based on practical science, than is accorded by the education department of this country.

Placed as is Britain, as it were between Europe and America, an Exhibition of Navigation and Travel would at all times appear to be singularly appropriate: but this has still greater significance at Liverpool, itself the second, if not the first, seaport of the world. This is rendered still more important from the evident care evinced by the projectors that the Exhibition should be on a scientific basis, and that it should be the means of spreading accurate scientific and technical knowledge in the construction and manipulation of all the appliances of locomotion, travel, and transport by sea and land, by rivers, by air, or through cultivated lands, or across the desert. In addition to this it is proposed, should, as is hoped, a surplus be realised at the end of the Exhibition, that it be devoted to the foundation of a school of technical education, to be called after the late Prince Leopold, whose last public appearance in Liverpool was marked by special advocacy of the claims of technical education.

Commerce and manufactures are also to be represented, including all substances used in the arts derived from animals, from vegetables, and from metallic and non-metallic minerals.

The Corporation of Liverpool has granted a site of 35 acres near the Edge Hill Station of the London and North-Western Railway; fountains, bands, and electric illuminated trees are to reproduce the features of South Kensington, and the scheme is not only supported by the cities of the north, but by Paris, Vienna, and Berlin, while Belgium, Sweden, and other countries, and the Isle of Man, are applying for courts. The Exhibition will be opened in May next year, and continue open for six months.
C. E. DE RANCE

DR. GOULD'S WORK IN THE ARGENTINE REPUBLIC

WE have from time to time during the last fifteen years recorded the progress made by Dr. Gould in his stupendous work on the southern stars. He has now returned to the United States, and we are glad to be able to give an account of the reception he met with on his return. Rarely has such a reception been better deserved, and carried out as it was it did credit to science all the world over, as well as to the country and the man most closely interested.

A letter signed by upwards of eighty of the most prominent men in Boston awaited Dr. Gould's arrival, asking him to fix a date "when it will be agreeable for you to meet us at a dinner, that we may welcome you home."

Pursuant to arrangement a reception and dinner took place at the Hotel Vendôme, Boston, on the evening of May 6, 1885. The Hon. Leverett Saltonstall presided, and, after the banquet, arose to introduce the guest of the evening. The president referred to Dr. Gould's early career and his hard work:—"We have thus met," he said, "that we may extend to Dr. Gould our most cordial welcome, to show him our high respect for his character and attainments, to express to him our deep sympathy for all the severe trials he has been called upon to encounter, and to prove to him in every possible way how proud we are of his high fame, world-wide, as one of the greatest astronomers of this or any former age. . . .

"When the opportunity presented itself for doing a far greater work than that, in my opinion, accomplished by any astronomer now living, and equalled in extent and importance by but few in any previous age, a work so vast in its design that its mere suggestion might well have staggered a much younger man, he already having passed what is considered the prime of life, courageously took the great step and exiled himself from home, conscious that it was a work which he could scarcely hope to live to complete. He buried himself in a country so far away and so little known that it might well have seemed another world, and with no hope of reward such as the world generally values for all the cause he loves with such devotion—the cause of science. He sailed with his family for Buenos Aires, and there for fifteen years he has been searching the heavens by night, and making his calculations by day, till he has finished a complete catalogue of the stars of the southern hemisphere. And in this great work, the greatest perhaps ever known, an exile from home, almost alone and unaided, feeling that on the continuance of his life and strength depended its accomplishment, he braved and endured all with a courage and devotion worthy of our highest admiration."

In reply to the toast of his health, Dr. Gould spoke as follows:—

MY DEAR FRIENDS,—Would that I knew how to give some fit expression to my deep sense of your kindness, and to my gratitude for this delightful manifestation of your approval and regard. No man could fail to be profoundly moved, or to indulge a pardonable pride, under such circumstances; and it is only natural that one, who is perhaps too sensitive to the opinions of those whom he loves and esteems, should find it difficult to control his emotions or to give full utterance to his thanks.

If the pursuance of my appointed task has entailed sacrifices, the chief among them has certainly been the long separation from the friends at home, whose companionship, encouragement and sympathy were always my greatest source of happiness, outside the narrow limits of domestic life. But there has been something more than mere separation; for, however cherished and abiding may be our memory in the hearts of the friends spared to us for that reunion to which we are always yearningly looking forward, there still remains the consciousness that we have ceased to form an element in their lives, and that all human associations become dulled by the lapse of time. Had I been able to foresee this welcome from those to whom I am most closely bound by ties of affection, sympathy and respect, the anticipation would have lightened many a weary hour, and given new strength when courage threatened to fail.

You, my dear classmates of forty years ago, like the other friends around us here, need not be reminded that public speaking was never comprised in the short list of my attainments. It will not surprise you that fifteen years' disuse of our native language should have given me no greater command of it, nor that an unremitting employment of telescopes and logarithm-tables, should have made it no easier to face a large assemblage, even though composed only of kind and indulgent friends. All that I can do is to offer to all of you my overflowing thanks, and to assure you that the long severance from friends and country, now at last ended, shall give greater earnestness to my resolve to atone in the future, as well as may be, for the past neglect of my duties to them and to this community, in which I will never abdicate my priceless birthright.

As you have implied in your too flattering words, that incentive has never been wanting during my expatriation, which came from the consciousness that whatever it might be within my power to accomplish well, would be credited in part to our native land. It is a source of pride to the Argentines that their political organisation was modelled upon that of the United States—that their precedents in constitutional law are based upon the decisions of North American courts, and that the word "America" vibrates in their ears with the same melody we know so well. If a conquest from the realm of the unknown be made by American effort, they rejoice in it, before considering which is the hemisphere whence the soldiery came. And the success of any laudable effort emanating from this western hemisphere is doubly prized by them when the two Americas have united for its accomplishment.

Science knows no narrow bounds of nationality; yet who would be so cruel or so unwise as to censure, or attempt to weaken, the intense stimulus which is given by the hope that what honour may attach to a good work will be reflected upon one's own country? Does not a part of the world's tribute to a Franklin, Fulton, Bache, Henry, Agassiz, or Peirce—to an Irving, Bryant, Prescott, Motley, or Longfellow (I name only such as have left us)—belong to their country? And is it not a wholesome incentive to the labourer that he should feel that a portion of his reward will be assigned to his country, or even in a wider sense, to his own continent, when this has started late in the race, handicapped by the shortness of its history and the restrictions of its past opportunities?

From this point of view it may not be unseemly if I comply with the request to relate briefly what has been attained at Cordoba in these fourteen and a half years, chiefly by North Americans, labouring in the service of the Argentine nation, which has never failed to afford them all needful support and encouragement.

The undertaking began, as you know, with the project of a private astronomical expedition, for which my friends in Boston and its vicinity had promised the pecuniary means. The selection of Cordoba, as an especially desirable place, was chiefly due to our lamented countryman, Gilliss, whose astronomical mission to Santiago de Chile had resulted in extensive and valuable observations of southern stars, and in the establishment of a national observatory, while it had enabled him to form a sound judgment as to the relative advantages of different points in South America for astronomical purposes, notwithstanding the total want of trustworthy meteorological data. This choice of place was confirmed by the counsel of the Argentine Minister to this country. That minister was Sarmiento, a man who needs no encomium here, for, during his brief residence in the United States, he gained an exceptional number of friends and admirers. He transmitted to his Government, then under the presidency of Gen. Mitre, my application for certain privileges and assurances, all of which were at once cordially conceded; but his interest in the plan became furthermore so great that when, soon afterwards, he was himself elected President, he obtained the assent of the Argentine Congress to the establishment of a national observatory, and wrote asking me to change my plans accordingly. The official invitation was sent in due time by the Minister of Public Instruction, Dr. Avellaneda. The Government assumed the expense of the instruments and equipments already bespoken, and authorised the engagement of the requisite assistants.

In 1874 Dr. Avellaneda succeeded Sarmiento in the presidency, and in 1880 he was himself succeeded by Gen. Roca. Thus, four successive administrations have encouraged and sustained the undertaking; and, notwithstanding the high political excitement which often prevails, and might easily have disinclined the members of any one party to give cordial aid to institutions established or fostered by its opponents, there has never been wanting a spirit of decided friendliness to the Observatory and to the scientific interests which have been developed under its auspices. No president of the nation, and no minister of the department under which the Observatory is placed, has failed to give strong practical evidence of his good will; there has been none of them to whom I do not owe a debt of gratitude; I have never made an official request which has not been granted, and almost always in such a way as to enhance the favour. And, just as the official founders of the Observatory met us with a cordial welcome on our arrival, so the Government of to-day has overwhelmed me with kindness and tokens of regard on my departure. On the very last evening before embarking—when it was my privilege to receive the farewells of a crowded assemblage in the halls of the Argentine Geographical Institute, and to hear words of sympathy and commendation from the lips of Gen. Sarmiento, my earliest Argentine friend, speaking in behalf of that Society—I replied, in the few words which alone were possible at the time, but with all sincerity and truthfulness, as follows:—

"It was you, sir, who provided the opportunity for which I was yearning; it was the Argentine Republic which made it easy for me to avail myself of it; it has been the National Government which, in its various phases, and under so many different administrations, always provided all needful means and resources; it is the Argentine people which has accompanied me in my tasks, giving support by their sympathy and incentive by their kindness."

The original purpose of the expedition was to make a thorough survey of the southern heavens by means of observations in zones between the parallel of 30° and the polar circle; but the plan grew under the influence of circumstances, until the scrutiny comprised the whole region from the tropic to within 10° of the pole—somewhat more than 57° in width, instead of 37°. Although it was no part of the original design to perform all the numerical computations, and still less to bring the results into the form of a finished catalogue, it has been my exceptional privilege, unique in astronomical history so far as I am aware, to enjoy the means and opportunity for personally supervising all that vast labour, and to see the results published in their definite, permanent form. Of course this has required time. The three years which I had purposed devoting to the less complete work have been drawn out to nearly fifteen ; and you will comprehend what that implies for one who loves the friends of his youth, his kindred, and his country. Yet even here there has been consolation. For, while the work has demanded all that period, it did not absorb the whole time, and opportunity was left for other studies. Among the astronomical ones it has been possible to examine all the stars as bright as the seventh magnitude, up to 10° of north declination, for careful estimates of their respective brilliancy, and to reform the arrangement and boundaries of the southern constellations. Also to carry out the observations and computations for another stellar catalogue, more precise than that of the zones, and extending over the whole southern hemisphere. The total number of stars in this catalogue is less than in the other; but that of the observations is greater, since each star has been observed several times, as well as with greater precision. This catalogue, too, is at last finished and in the hands of the printer, and thus it is that I am once more at home with you, my cherished friends.

I am hopeful that the data now collected may throw some additional light upon the great problem of the distribution of the stars in space. Yet, even should these prove insufficient, there is reason to believe that the new labours, already begun by my successor, Dr. Thome, who has been connected with the observatory from the very first, will provide whatever additional information may be needful for the purpose. Among the other researches which have gone forward, while the preparation of the zone-catalogue dragged its slow length along, has been a study of the meteorology of the country. The absolute lack of information on the subject had forced itself unpleasantly upon my notice when endeavouring to select the most suitable place for the observatory ; and, as it would have been disgraceful for any scientific inquirer to reside in the country without trying to supply the want in some degree, I succeeded in enlisting the aid of various educated men and women in different parts of the country and adjacent ones. The Government and Congress acceded to my recommendation that a modest sum should be annually appropriated for the purchase of barometers, thermometers, rain-gauges, &c., to be lent to volunteer observers, and for arranging, computing, and publishing the results. In this way was organised, in 1872, the Argentine Meteorological Office, which has established no less than fifty-two stations, scattered from the Andes to the Atlantic, and from Bolivia to Tierra del Fuego. At the end of the year 1884 there were already twenty-three points at which the observations had been continuously made, three times a day, for at least four years, and sixteen others at which they had already been continued for more than two years. These have provided the necessary data for constructing the isothermal lines, with tolerable precision, for all of South America from the torrid zone to Cape Horn. Some little has also been accomplished in determining local constants of terrestrial magnetism ; and our determinations of geographical position have nearly kept pace with the extension of the telegraph wires. The beats of the Cordoba clock have been heard and automatically recorded amid the plash both of Atlantic and Pacific waves. And the series of longitude determinations made by the United States naval expeditions, between Buenos Aires and Europe on the one side, under Capt. Green, and between the United States and Valparaiso under Capt. Davis on the other, give, when combined with the two South American measurements, values for the longitude of Cordoba, which differ only by one-sixth of a second—this being the total amount of the aggregate errors of the several determinations in a series which, passing through Brazil, the Cape Verde Islands, Madeira, Portugal, England, Ireland, Newfoundland, the United States, Central America, and down the coasts of Ecuador, Peru, and Chile, completes the full circuit at Cordoba again.

But I will not descant upon collateral matters, nor convert this gathering of friends into an astronomical lecture-room. There are but two points more that I wish to mention.

One is, that I cherish a hope that our sojourn at Cordoba may hereafter be considered as marking an epoch in a new method of astronomical observation, namely, the photographic. The inception and introduction of this method belongs to our countryman, Mr. Rutherfurd ; and it was only through his friendly aid in several ways that I was enabled to give it a larger scope, in spite of many obstacles. Now I can report that every important cluster of stars in the southern hemisphere has been repeatedly photographed at Cordoba with a precision of definition in the stellar images which permits accurate microscopic measurement ; that these measurements are at present actively going on, and that the Argentine Government has undertaken to provide the means for their continuance under my supervision. It may be that I over-estimate the importance of this new method ; but I confess that my expectations are very high. Another year ought to show us whether they are exaggerated or not.

The other point is, that a very large share of the merit which you so liberally attribute to me belongs to the faithful staff of fellow workers, with whose assistance I have been singularly favoured. Their unselfish devotion to the great undertakings in which they took part, their loyalty, trustworthiness and ability, have, in the great majority of cases, been beyond all praise. Happily, their faithful and inestimable services to science are placed on durable record ; and yet unborn astronomers will know, at least in part, how great have been their deserts. The senior of them, Dr. John M. Thome, whose services began in 1870, before we started southward, is now director of the Observatory, where he has begun a new and important work, which will do honour to him and to the institution. Another, Mr. Walter G. Davis, who has laboured most earnestly and efficiently for eight and a half years, is now director of the Meteorological Office, which is assuming large proportions, and under which he is now organising at Cordoba a meteorological station of the highest class. One noble young man, Mr. Stevens, was summoned, without an instant's warning, to a higher reward than earth could give, leaving no memories behind him other than of affection, admiration, and respect. It was a sore loss for us, and for the bereaved parents in New Hampshire, to whom he was their only earthly stay and staff. Had he lived, his friends and country would have had abundant cause for pride in him. As it is, the number of those who love and honour his memory may perhaps be smaller, but their pride and admiration are no less, than had they seen the full harvest instead of the rich promise only. Mr. Bachmann, a native of Austria, who laboured with us for more than ten years, is now at the head of the Argentine Naval Academy in Buenos Aires, with more than three hundred pupils and an elegant little observatory, where he finds repose from administrative cares, in astronomical work analogous to that to which he gave his energies at Cordoba. He has already undertaken some longitude-determinations and arranged a time-ball, which is probably by this time giving daily signals by which the shipping in the outer roads, twelve miles away, may correct and rate their chronometers.

I have spoken longer than I intended, but will make no apologies, for I know your friendly indulgence. It only remains to say, for these Argentine scientific institutions, that I believe their success is now assured. They will enter upon new and enlarged fields of usefulness, as indeed they ought, for the world moves. And for myself, that the remembrance of this occasion and of your goodness will be a source of pride to me through life, and to my children afterwards.

Hardly had the sound of Dr. Gould's voice died away when he was the recipient of a splendid ovation, the guests of the evening seeming to vie with each other in a generous rivalry as to which should outdo the other in rendering honour to the distinguished guest of the evening.

The chairman, in introducing Dr. Oliver Wendell Holmes, pleasantly referred to him as not a small star, but one of the first magnitude. Dr. Holmes received just such a welcome as he is entitled to, and which is always accorded him, and in response thereto read the following poem, which was received with round after round of applause :—

A Welcome to Dr. Benjamin Apthorp Gould

Once more Orion and the sister Seven
 Look on thee from the skies that hailed thy birth—
How shall we welcome thee, whose home was Heaven,
 From thy celestial wanderings back to earth?

Science has kept her midnight taper burning
 To greet thy coming with its vestal flame :
Friendship has murmured, "When art thou returning?'
 "Not yet! Not yet!" the answering message came.

Thine was unstinted zeal, unchilled devotion,
While the blue realm had kingdoms to explore—
Patience, like his who ploughed the unfurrowed ocean,
Till o'er its margin loomed San Salvador.

Through the long nights I see thee ever waking,
Thy footstool earth, thy roof the hemisphere,
While with thy griefs our weaker hearts are aching,
Firm as thine equatorial's rock-based pier.

The souls that voyaged the azure depths before thee
Watch with thy tireless vigils, all unseen—
Tycho and Kepler bend benignant o'er thee,
And with his toy-like tube the Florentine—

He at whose word the orb that bore him shivered
To find her central sovereignty disowned,
While the wan lips of priest and pontiff quivered,
Their jargon stilled, their Baal disenthroned.

Flamsteed and Newton look with brows unclouded,
Their strife forgotten with its faded scars—
(Titans, who found the world of space too crowded
To walk in peace among its myriad stars).

All cluster round thee—seers of earliest ages,
Persians, Ionians, Mizraim's learned kings,
From the dim days of Shinar's hoary sages
To his who weighed the planet's fluid rings.

And we, for whom the northern heavens are lighted,
For whom the storm has passed, the sun has smiled,
Our clouds all scattered, all our stars united,
We claim thee, clasp thee, like a long-lost child.

Fresh from the spangled vault's o'erarching splendour,
Thy lonely pillar, thy revolving dome,
In heartfelt accents, proud, rejoicing, tender,
We bid thee welcome to thine earthly home.

The Rev. James Freeman Clarke in saying a word in honour of "our friend, the eminent astronomer, who is our guest to-night," remarked that—

"We are on the verge of still greater discoveries than any yet made, and our own country is prepared to do its full part in the work. When the Russian Government wishes for a better telescope than any now in Europe, it sends to Cambridgeport to get it. Mr. Rutherfurd invents an instrument which gives us the best photographs of the moon ever made. The Washington Observatory discovers the two satellites of Mars. Prof. Langley, in the midst of Pittsburg smoke, has made observations with instruments of his own invention, with an account of which he is now arousing great interest among the men of science of England. Dr. Peters, of Clinton, N.Y., and Prof. Watson, of Ann Arbor, have been the chief discoverers of the asteroids. Prof. Young and Harkness first gave, in 1869, the true theory of the solar corona. The two Bonds, at the Cambridge Observatory, have taken rank among the chief astronomers of our time. Our friend, Prof. Pickering, amid all his other labours, has invented instruments of precision by which the light of the stars can be measured with accuracy. And now we welcome home Dr. Gould, who has given long years of labour in a far-off land, away from home and friends, to complete his great work of a catalogue of the southern stars. To him and to his noble wife who shared his labours, sustained his courage, was his companion in his sacrifices, we give our thanks and our love to-night. We sympathise with him in that great loss, and we thank God with him that he and she had this great opportunity, and that they were able to share together, side by side, the consciousness of doing a work which will never be forgotten."

Other tributes were paid to the work of Dr. Gould by Prof. Lovering, of Harvard, Prof. Pickering, of Harvard Observatory, Dr. William Everett, Prof. W. A. Rogers, of Harvard. The last-named said that there is no exaggeration in the statement that the work which Dr. Gould has accomplished during the past thirteen years is without a parallel in the annals of astronomy.

"First of all it needs to be said that in 1870 there was no Cordoba Observatory. I suspect, also, that it must be said that astronomers had at that time little faith in the fulfilment of plans which required that the Government of a South American Republic should persistently pursue, for a series of years, that wise, enlightened and liberal policy which has made the Argentine Republic a conspicuous example of the way in which a government may foster learning and research with the most encouraging results. I do not know of a better way to give a clear idea of the magnitude of this work than by comparing it with similar work done previous to 1872. There are in the northern heavens, between the north pole and a little distance below the equator, about 4500 stars visible to the naked eye. These stars have been observed with more or less regularity at various observatories since about 1750. Within the same limits there are about 95,000 stars as bright or brighter than the ninth magnitude, which are usually observed in narrow belts or zones, and such stars are usually referred to as zone stars. The bright stars are common to nearly all general catalogues, but the positions of the fainter stars depend for the most part on two or three separate observations. Dr. Gould has formed two catalogues since 1872 —a general catalogue of stars extending to the south pole, containing 34,000 stars, and a catalogue of zone stars, numbering 73,000. These two catalogues represent about 250,000 separate observations. It is stated in one of the printed volumes that the chronographic register of the transits, the pointing of the telescope for declination, and the estimation of the magnitude have all been done by Dr. Gould personally. The distinct and separate observations involved in this work must certainly exceed 1,000,000. I suppose there must be several gentlemen present who have a realising sense of what a million really means, but for myself I commonly say that it seems to me to be a very large number. Having made less than 50,000 observations during the time covered by Dr. Gould's observations, can you wonder that this work, which seems so far beyond the limit of human endurance, is at once my amazement, my admiration, and—I must add—my despair? The whole number of stars in the two Cordoba catalogues is nearly three times as great as in any single catalogue thus far constructed; and it must be remembered in this connection, that the great catalogues of Lalande, of Bessel, of Argelander, and of Schjellerup, represent the labours of a life-time. The total number of stars in all catalogues formed previous to 1870, is about 260,000 as against the 105,000 stars in the Cordoba catalogues. But there is another comparison which may be made, which will reveal yet more clearly, not only the magnitude of the work which Dr. Gould has now finished, but the intense energy with which it has been pushed to completion. Since 1869 a confederation of fourteen observatories, situated in different parts of the world, has been engaged in the accurate determinations of the positions of the 100,000 stars to the ninth magnitude, in the northern heavens. Up to 1882 a total of about 346,000 observations had been made. Considerable progress had been made in this work before Dr. Gould left this country for South America. His work, involving two-thirds as many observations as all others combined, is completed, and is all in the hands of the printer, while the actual formation of the catalogue to be issued under the direction of the Astronomische Gesellschaft can hardly be said to have been begun."

TELPHERAGE

ON Saturday, October 17, a special train from Victoria conveyed a party of about 200 guests, among whom were many leading electricians, engineers, and other well-known men of science, to Glynde, in Sussex, to witness the ceremony of the opening of the first telpher line erected in this country. The ceremony was performed by the Viscountess Hampden, and was of an exceedingly simple character; on lifting a small box containing a present which the Chairman of the Company invited her ladyship to accept, electric communication was instantly established between the dynamo in the engine-house and the telpher line, and a train loaded with clay at once began to move up an incline towards the Glynde Railway Station, amidst the applause of the assembled spectators. Whether this ceremony, which brought so many distinguished visitors down to Lord Hampden's estate on Saturday, is the inauguration of a great commercial enterprise is beyond our province to inquire; but it is unquestionable that the slight flash seen when Lady Hampden lifted the little box lying on the table in front of the engine-house marked the beginning of a new departure in electro-technology.

Telpherage has been defined as the transmission of goods and passengers by means of electricity without driver, guard, signalmen, or attendants. The conception of propelling electrically a continuous stream of light trains along an elevated *single* rail or rope was due to the late Prof. Fleeming Jenkin, but, as stated by him in his introductory address at the University of Edinburgh, he did not see his way to carry this conception into practice until he read the account of the electrical railway exhibited by Professors Ayrton and Perry at the Royal Institution in 1882, when the idea of subdividing the rubbed conductor into sections and providing an *absolute block* for automatically preventing electric trains running into one another was first publicly described. A combination between these three gentlemen was then effected, which led ultimately to the formation of the Telpherage

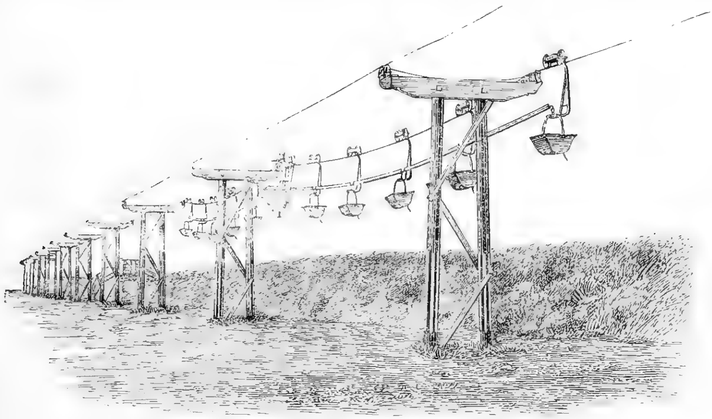


Fig. 1.

Company and to the series of experiments, lasting for over two years, on actual telpher lines erected at Weston in Hertfordshire, on the estate of Mr. Pryor, the chairman of the company. Various devices were worked out forming the subject of patents, which, together with the other patents of Professors Fleeming Jenkin, Ayrton, and Perry in telpherage, previously taken out, are possessed by the present Telpherage Company. At the commencement of this year matters had sufficiently advanced for the erection of commercial telpher lines, and as a tramway or road would have much interfered with the grazing and hay growing carried on in the fields at Glynde, and, as in addition these fields are under water during the winter, telpherage appeared to furnish the cheapest and most suitable mode of carrying the clay from the clay pits to the London, Brighton, and South Coast Railway. Con-

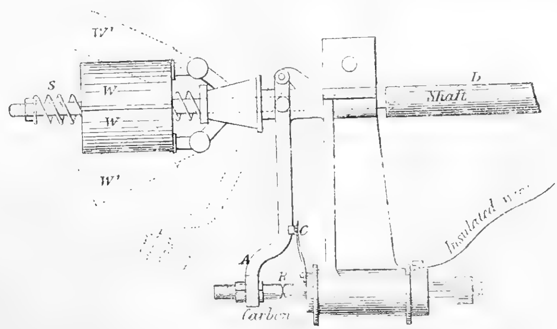


Fig. 2.

sequently the Sussex Portland Cement Company decided to adopt this method of transport.

The line now opened is nearly a mile long, and composed of a double set of steel rods each 66 feet long, three-quarters of an inch in diameter, and 8 feet apart, supported on wooden posts standing about 18 feet above the ground, as seen in our illustration (Fig. 1), which is from a photograph taken of the line just before it crosses the stream. On the death of the late lamented Prof. Jenkin the construction of the Glynde telpher line was left for completion in the hands of Prof. Perry, who was then appointed the engineer to the company. The new line, it must be understood, is more than a mere experimental attempt. Although, as scientific men will appreciate, a new undertaking must necessarily involve much tentative experience, the programme carried out on Saturday marked the final result of the experiences gained by the constructors under the direction of Prof. Perry, and the Company are now regularly delivering clay at the Glynde Railway Station for the use of the Newhaven Cement Company at a price, as we are informed, of $7\frac{1}{2}d.$ per ton.

The garlanded train which passed along the steel rodway on Saturday consisted of an electric locomotive, seen in Fig. 1 at about the middle of the train and propelled by the electromotor M, and ten skeps, or buckets, which hang by their travelling wheels from the steel line. Each skep weighs 101 lbs., and carries 250 to 300 lbs. of dry clay, and, by distributing these evenly and somewhat widely

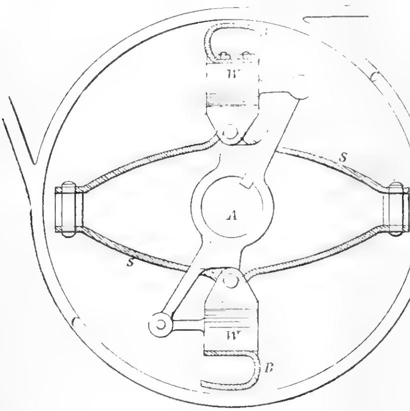


Fig. 2.

apart, the strain on the steel line is small although the total weight of the train and clay is about two tons, also as equal weights are simultaneously ascending and descending similar inclines on the several spans the effect of the sag on the mechanical resistance of the train is neutralised, and little more resistance is experienced than in hauling a similar train along a rigid road. The rate of travelling is 4 to 5 miles an hour about two electric horsepower only being necessary to be furnished at the engine-house to propel the train at this speed, and the train is under the control of a workman, who, by touching a key, can start, stop, or reverse the train at pleasure. On the arrival of each telpher train at the railway siding the clay is emptied into the railway waggons by the skeps being tipped over, this being effected either by a man touching with a pole the handles which are seen in Fig. 1 hanging down from the skeps, or automatically by these handles coming successively into contact with a wooden arm padded with india-rubber which is made to stand out from the post where it is desired the clay is to be emptied. One train will deliver the minimum amount of clay (150 tons per week) required by the Cement Company, but, if necessary, twenty trains can be run on the line without fear of a collision as an absolute automatic block is provided, and the trains are, moreover, governed automatically so as to run up or down an incline at the same speed.

This automatic governing of the speed of the train is effected in two ways—first, there is a governor attached to each motor, which interrupts the electric circuit, and cuts off the power when the speed becomes too high; secondly, there is a brake which is brought into action should the speed attain a still higher value. To avoid the formation of a permanent electric arc when the circuit is broken, the governor (Fig. 2) is so arranged that the diverging weights are in *unstable* equilibrium between two stops—they fly out at about 1700 revolutions per minute of the motor, and fly back at about 1600. When the circuit is closed the current is conveyed across the metallic contact at C. When the weights W W fly out this contact is first broken, but no spark occurs because a connection of small resistance is continued at B between the piece of carbon and a piece of steel, which being pressed out by a spring follows the carbon for a short distance as the arm A begins to fly out. This contact is next broken, producing an electric arc, which however is instantly extinguished by the lever A flying out to the dotted position. The brake is shown on Fig. 3, and consists simply of a pair of weights, W W, which at a limiting speed greater than 1700 revolutions per minute of the motor press the brake blocks B B against the rim C C, and introduce the necessary amount of retarding friction. In practice, however, with the gradients such as exist at Glynde, and which do not exceed 1 in 13, the economic method of automatically cutting off the power with the governor is all that is necessary to control the speed of the train; the brake rarely coming into action. With steeper gradients, however, the brake would undoubtedly be very useful.

The current required is 8 amperes per train, this current being measured by an ammeter in the engine-house, and by roughly timing the intervals when no current is being given to a train, that is, when the governor is acting, the particular hill the train is descending can be electrically determined by practice, and so the progress of a train

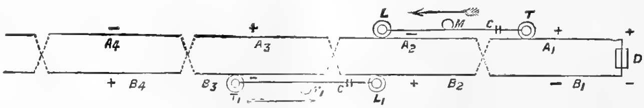


Fig. 4.

along the telpher line can be approximately followed by simply watching the ammeter in the engine-house. The electric current is supplied from a 200-volt dynamo driven by a steam-engine, and controlled by a Willans electric governor which automatically varies the speed of the engine and dynamo so as always to keep the electromotive force at 200 volts whatever be the number of trains running; hence the starting or stopping of one telpher train in no way affects the speed of the remainder. It is obvious that water-power or any other source of power can be used where available, even when the source of power is at a considerable distance from the line. By means of compensating gear the tension of the line is so regulated that it can never exceed $2\frac{1}{4}$ tons on each rod, whatever the temperature, and for straining the steel rods, when first erected, up to the right tension an ingenious arrangement has been devised during the construction of the line of vibrating them and determining the strain on a rod from the number of vibrations it makes per minute.

The way in which a single wheel track is made to serve for one train, or rather two wheel tracks for two trains, instead of the necessity of having four wheel tracks for two trains, as in the ordinary electric railways, is seen from Fig. 4. D is the dynamo maintaining two long conductors permanently at different potentials indicated by the signs + and − of each section. The wheels L and T of one train, and L_1 and T_1 of the other, are insulated from their trucks and joined by a conductor attached respectively to the terminals of the motor M and M_1. A current consequently is always passing from a + section to a − section through each motor. Mechanically then each train is supported by what is practically one continuous steel rod, but in reality at the tops of the posts the rods are electrically subdivided into sections and joined across by insulated wires, one of which may be seen at the top of the posts in Fig. 1. The wires connecting the two skeps with the motor, shown in Fig. 4, are not seen in Fig. 1, as they were too thin to appear in the photograph from which this figure was taken. To prevent the metallic wheels of the skeps short circuiting the two sections as they cross the tops of the posts, there are insulated gap pieces, which may be seen in Fig. 1, at the tops of the posts where the steel rod is electrically divided.

Various devices have been tried for gripping the rod to obtain the hold necessary to enable the locomotive to haul the train, and these, with many ingenious plans of *nest gearing* for economically communicating the power given out by the very quickly revolving electro-motor to the much more slowly moving wheels of the telpher locomotive, formed the subject of Prof. Jenkin's lecture at the Society of Arts in the spring of 1884. Practically, however, it is found that for moderate inclines direct driving, with pitch chains, of two wheels with india-rubber treads gives a gravitation grip sufficiently large for satisfactory haulage; hence the expense of the locomotive, the complexity and wear and tear of its parts combined with the risk of its getting out of order have been all most materially reduced during the last twelve months.

As the result of the experience gained in the construction of the Glynde line, it is estimated that a similar line could now be erected at short notice for a total cost of 1200*l.*, including engine, dynamo, permanent way, and five trains, with locomotives to carry 100 tons daily; the working expenses, including coal, attendance, and depreciation, being less than 3*d.* per ton per mile upon the material carried. A double line like that at Glynde, ten miles long, worked heavily, would carry material at a cost of 2*d.* per ton per mile, the skeps being empty on their return journey. The larger part of the original cost of the Telpher line is due to dynamos and rolling stock. This plant can be increased, as we are informed, in proportion to the work required, so that there is a very moderate increase of cost in the rate per ton per mile for a small traffic, as compared with a larger one. On the other hand, a line constructed for a small traffic will accommodate a much larger one with no fresh outlay on the line itself.

Leaving these facts and figures to speak for themselves, it now only remains to point out the advantages claimed for this system of electric carriage. In the first place the facility with which such a line can be run up and carried over uneven ground or across streams, high fences, and deep ditches, where an ordinary railway would involve serious expense, is sufficiently obvious. A Telpher line need not, as a railway necessarily does, impede the ordinary agricultural operations, but may be carried over fields and pasture lands with little inconvenience. The Telpher line is, moreover, in itself a source of power which can be simultaneously tapped at any desired points and made to assist in the work of agriculture, as the visitors on Saturday had an opportunity of witnessing when, by means of a motor connected with the line, a turnip-cutter was put into operation. The possibility of utilising natural sources of power like falling water, and of working the line at great distances from such sources will, as already stated, be evident to our readers. A special advantage claimed for the new system is the ease with which the trains can go round sharp curves without loss of power, since electricity, having no momentum, experiences no loss in going round a corner, whereas, with the overhead wire haulage system, as used in Spain and elsewhere, there is both considerable friction and great wear and tear of the running wire ropes where they go round sharp curves.

The constructors of the Glynde Line are careful to point out that the present line is far from perfect; unnecessary gradients have been introduced in order to show how the system can be carried over uneven land, and many other improvements have suggested themselves in the course of their experience, of which advantage would be taken in future undertakings. In face of these disadvantages, the success which marked Saturday's proceedings renders Telpherage, as a system, a very hopeful and cheap method of transference, and the Company is to be congratulated in having taken the first initiative step in this new application of electricity. That Telpherage will ever come into serious competition with the large railways is not intended, for the statement made by the Company is to the effect that the function of the Telpher line is not to compete with railways, but to do cheaply the work of horses and carts, light tramways, and the wire rope haulage system, and this, we think, it has a good chance of successfully accomplishing.

THE MELDOMETER

THE apparatus which I propose to call by the above name (μέλδω, to melt) consists of an adjunct to the mineralogical microscope, whereby the melting points of minerals may be compared or approximately determined and their behaviour watched at high temperatures either alone or in the presence of reagents.

As I now use it it consists of a narrow ribbon of platinum (2mm. wide) arranged to traverse the field of the microscope. The ribbon, clamped in two brass clamps so as to be readily renewable, passes bridgewise over a little scooped-out hollow in a disk of ebony (4 cm. diam.). The clamps also take wires from a battery (3 Groves cells), and an adjustable resistance being placed in circuit the strip can be thus raised in temperature up to the melting point of platinum.

The disk being placed on the stage of the microscope the platinum strip is brought into the field of a 1″ objective, protected by a glass slip from the radiant heat. The observer is sheltered from the intense light at high temperatures by a wedge of tinted glass, which further can be used in photometrically estimating the temperature by using it to obtain extinction of the field. Once for all approximate estimations of the temperature of the field might be made in terms of the resistance of the platinum strip, the variation of such resistance with rise of temperature being known. Such observations being made on a suitably protected strip might be compared with the wedge readings, the latter being then used for ready determinations. Want of time has hindered me from making such observation up to this.

The mineral to be experimented on is placed in small fragments near the centre of the platinum ribbon, and closely watched while the current is increased, till the melting point of the substance is apparent. Up to the present I have only used it comparatively, laying fragments of different fusibilities near the specimen. In this way I have melted beryl, orthoclase, and quartz. I was much surprised to find the last mineral melt below the melting-point of platinum. I have, however, by me as I write, a fragment, formerly clear rock-crystal, so completely fused that between crossed Nicols it behaves as if an amorphous body, save in the very centre where a speck of flashing colour reveals the remains of molecular symmetry. Bubbles have formed in the surrounding glass.

Orthoclase becomes a clear glass filled with bubbles:—at a lower temperature beryl behaves in the same way.

Topaz whitens to a milky glass—apparently decomposing, throwing out filmy threads of clear glass and bubbles of glass which break, liberating a gas (fluorine?) which, attacking the white-hot platinum, causes rings of colour to appear round the specimen. I have now been using the apparatus for nearly a month, and in its earliest days it led me right in the diagnosis of a microscopical mineral, iolite, not before found in our Irish granite, I think. The unlooked-for characters of the mineral, coupled with the extreme minuteness of the crystals, led me previously astray, until my meldometer fixed its fusibility for me as far above the suspected bodies.

Carbon slips were at first used, as I was unaware of the capabilities of platinum.

A form of the apparatus adapted, at Prof. Fitzgerald's suggestion, to fit into the lantern for projection on the screen has been made for me by Yeates. In this form the heated conductor passes both below and above the specimen, which is regarded from a horizontal direction.

J. JOLY

Physical Laboratory, Trinity College, Dublin, November 1

NOTES

OUR readers will hear with regret that Prof. Huxley has placed in the hands of the Council of the Royal Society his resignation of the office of President, and that the Council have felt it their duty to accept that resignation. It would appear that Prof. Huxley had wished to resign so long ago as November last, when he had decided to winter abroad, and again, last summer, he definitely placed his resignation in the hands of the Council. On both these former occasions Prof. Huxley was induced to continue in office, in the hopes that he would soon regain complete health. On the present occasion we gather that the resignation was accepted, because, though Prof. Huxley is rapidly improving in health, the cares of the presidential chair seemed likely to prove a hindrance to his complete recovery being so rapid as could be desired. We feel sure that the whole scientific world will share the regret of the Council of the Royal Society at the necessity of such a step, but we also feel that every one must recognise the wisdom of the decision. We may add that every one hopes that freedom from the responsibilities of office may soon convert the marked improvement in Prof. Huxley's health, visible to all his friends, into complete and perfect restoration.

WE understand that Prof. Stokes has consented to allow himself to be nominated as Prof. Huxley's successor in the presidential chair. We believe that this choice of the Council will give universal satisfaction to the Fellows of the Society; while it makes Prof. Stokes doubly the successor of Newton, it does honour to the Society.

A CONSIDERABLE portion of the "Zoological Record" for 1884 has already been issued to subscribers; the Reports on Coleoptera, Lepidoptera, and Hymenoptera, by Mr. W. F. Kirby, were issued in September, and those on Reptiles, Fishes, Mollusca, Tunicata, Polyzoa, and Brachiopoda last week. The remaining parts are in a very forward state, Mr. W. L. Sclater, B.A., having undertaken the Mammalia in the place of Dr. Murie.

THE French Government has just created a certain number of travelling-juries. This is a modified form of an institution established by the first Republic. In the organic law of the Institut it was ordained that the Institut was to select yearly ten citizens to travel abroad and collect information useful to science, commerce, and agriculture. These scientific travellers will not be appointed by the Academy of Sciences or the whole Institut, but by a special administrative commission on the basis of a competitive examination.

WHILE so much public attention is attracted by the second part of the Greville "Memoirs," it will interest our readers to learn that the acute and observant Clerk to the Council, who, on the whole, had a very low idea of the great men with whom he came in contact, possessed a great respect for the men of science of his generation. Under March 17, 1838, we find the following interesting entry ("Memoirs," vol. i. p. 78):—"Went to the Royal Institution last night in hopes of hearing Faraday lecture, but the lecture was given by Mr. Pereira upon crystals, a subject of which he appeared to be master, to judge by his facility and fluency; but the whole of it was unintelligible to me. Met Dr. Buckland and talked to him for an hour, and he introduced me to Mr. Wheatstone, the inventor of the electric telegraph, of the progress of which he gave us an account. I wish I had turned my attention to these things and sought occupation and amusement in them long ago. I am satisfied that, apart from all considerations of utility, or even of profit, they afford a very pregnant source of pleasure and gratification. There is a cheerfulness, an activity, an appearance of satisfaction in the conversation and demeanour of scientific men that conveys a lively notion of the *pleasure* they derive from their pursuits. I feel ashamed to go among such people when I compare their lives with my own, their knowledge with my ignorance, their brisk and active intellects with my dull and sluggish mind, become sluggish and feeble for want of exercise and care."

THE first volume of "Geology, Chemical, Physical, and Stratigraphical," by Prof. Joseph Prestwich, F.R.S., will be ready for publication immediately by the Clarendon Press. This work is a general treatise on Geology adapted both for elementary and advanced students. Vol. I. treats of questions in chemical and physical geology, and special attention is paid to such subjects, among others, as Hydro-Geology, the geological bearings of the recent deep-sea explorations, volcanic action, joints, mineral veins, the age of mountain ranges, and metamorphism. Vol. II., which is far advanced, treats of stratigraphy and palæontology, and touches upon various theoretical questions. The author advocates the *non-uniformitarian* views of geology. The book is copiously illustrated with woodcuts, maps, and plates.

FATHER DENZA, according to the *Times* Rome correspondent, writing from the Observatory of Moncalieri, gives interesting particulars of a remarkable shower of dust which fell in various parts of Italy in the night of October 14–15. This dust-shower accompanied the violent gale of wind which occurred at the time, and seems to have fallen thickest in places situated more or less in the latitude of Rome. Father Denza regards the dust as meteoric. Mr. Abercromby writes to the *Times* to point out that this is probably premature, if by meteoric Father Denza means the product of meteors. But is it not probable that by meteoric sand he simply means sand which falls as "a meteor" or meteorological phenomenon? As Mr. Abercromby points out, this dust probably came from the Sahara.

AN interesting series of papers, copiously illustrated by charts, and comparative tables, is appearing in *Naturen*, on the climate of Norway. The author, Dr. Hesselberg, enters fully into the various causes on which depend the great differences between the inland and littoral climates, and notes in detail the varying relations of temperature for each month in the interior, and on the coast. From these tables it would appear that while in Norway, generally, the five months, from November to March inclusive, exhibit a purely winter temperature, no single month presents throughout a complete summer temperature. The remaining four months pass through the various stages of temperature between winter and summer. In the more northern and more elevated parts of the interior not a single month of the year is free from the risk of night-frost, while in such localities frost occurs on from 225 to 230 days in the year. On the coastlands, on the other hand, the mean winter temperature is generally from 2° to 3° Cels. above the freezing point, and here the greatest cold occurs in February, while in the interior December and January are the coldest months.

WE learn, from a recent report by Herr Reusch, of the condition of the Bommelö gold-mines worked by Messrs. Oscar and Daw, that gold to the value of 8000 kroner has been obtained during the three months in which these works have been in operation. The writer believes the mines may be made remunerative, but only moderately so, and provided they are worked with care and economy, and he emphatically warns his countrymen not to waste time and money, as has frequently been done in Norway, in seeking for gold in localities where the existence of any appreciable quantity of quartz is not well attested beforehand. He, moreover, points out the fallacy of believing that any large proportion of the auriferous quartz deposits of Norway are capable of yielding more than the mere fragmentary traces which are so constantly met with. Quite recently, indeed, the presence of gold has been shown in new localities, Herr Hansen having obtained in the quartz at Haugesund a number of microscopically small granules of the precious metal with titanic iron, while at Mæland, in Bommelö, about four miles from the spot where the first finds were made, he extracted gold after crushing and washing the white quartz which occurs in large lumps, accumulated on a hillock about 5 feet high, by 36 in length, and 13 in breadth.

PÈRE DECHEVRENS, the head of the Zi-ka-wei Observatory near Shanghai, has published a pamphlet entitled, "The Meteorological Elements of the Climate of Shanghai: Twelve Years of Observations made at Zi-ka-wei by the Missionaries of the Society of Jesus." It is a series of tables containing "all the information that meteorology can supply concerning the climate of Shanghai." A complete meteorological period in China is said to be about eleven years, and consequently this pamphlet embraces one such period. The tables show maximum and minimum, mean and normal readings of the barometer and thermometer, intensity of solar radiation, relative and absolute humidity, nebulosity, rainfall, and direction and velocity of the wind for every month throughout the twelve years, conveniently tabulated for comparison. There is also a table of eight years' observations of ozone, and a special section is devoted to terrestrial magnetism. Explanations are given in most cases of the methods of taking the various observations, and the objects which they serve. The readings are all given according to English methods of computation; but for the convenience of those who are more familiar with the metric barometer scale and the centigrade degrees of temperature, tables for the conversion of the English into the Continental systems are given.

AMONGST the anthropological papers recently issued by the Smithsonian Institution, special interest attaches to the memoir by Lieut. C. E. Vreeland and Dr. J. F. Brandsford on the antiquities recently discovered on the Pantaleon estate, near Santa Lucia, Guatemala. This place, which lies about thirty miles north-west of Escuintla on the railway from San José to the city of Guatemala, was visited in 1884 by the authors for the purpose of photographing the objects, which had here been observed two years previously by Dr. Brandsford, and earlier by Dr. Habel. Several of the finest specimens had been removed to Berlin, where an account of them was published by Dr. Adolph Bastian. Those here described and figured from the photographs form a group of remarkable sculptures, all of black basalt or hard lava mounted on a low wall round the fountain of the Pantaleon courtyard, and disposed in front of a grand central piece raised on a pedestal. This figure, which is in an excellent state of preservation, the nose alone being injured, is a new revelation in native American art, characterised by great strength and simplicity of outline. It is well formed, the lines simple and clearly cut, without a trace of the usual conventional style. Majesty is so plainly stamped on the countenance, that it was known to the Indians by the name of El Rey—the king. The brow, the eyes, and the nose, as far as can be judged, are in good shape and well proportioned; the mouth hard, the chin firm and full of character. Near it stands the head of an old person whose venerable appearance is heightened by the deep lines on brow and cheek. In contrast to this is another head of an old person, where calmness of expression is replaced by the inexpressible sadness of age with blindness. As in the case of some other figures, the eyes are here represented as hanging from the sockets, the balls resting on the cheeks. The chin and lower lip protrude, while the upper lip has fallen in as from the loss of teeth. To the long ears are appended large pear-shaped ornaments, and the turban-like headdress is surmounted with a little Tam O'Shanter cap. All the figures show real artistic skill, far beyond the elaborate but fantastic style of the conventional sculptures found at Copan and other parts of Central America.

A BORE-HOLE made about two years ago to a depth of 52 metres into the older Devonian strata near Burgbrohl on the Rhine, yields a large and steady supply of carbonic acid gas (with water) which is variously utilised. In a recent paper to the Niederrheinische Gesellschaft in Bonn, Herr Heusler says the normal quantity of gas amounts to about 2160 cubic metres in twenty-four hours. The supply having proved constant, a compressing apparatus was set up last autumn; the gas being taken directly over the bore hole. The present system produces per minute from 500 litres of gaseous $C.O_2$., 1 litre of liquid, weighing 1 kilogram. As the liquefaction depends on the external air-temperature, and is impossible at a temperature over 30·9 C. (the critical point), it is necessary in high temperatures to cool the apparatus, and the water of the spring (which keeps at 12°) serves for this. The pressure employed ranges from about 50 to 70 atmospheres. The wrought-iron vessels for despatch of the liquid contained about 8 litres, or 8 kilograms, and are tested to about 250 atmospheres; they very rarely explode. The enormous expansion of carbonic acid with rise of temperature yields a pressure which is utilised, it is known, for compression of steel and other casts, and Messrs. Krupp at Essen have thus got, *e.g.* a pressure of 1200 atmospheres for a temperature rise of 200° C. Among other rises are pressure of beer, impregnation of natural water, apparatus for fire extinction, motor force for torpedoes, &c. Solid carbonic acid is to a large extent produced from liquid by opening the cock of the vessel into a canvass bag tied over the mouth.

IN his recent investigation of pile-dwellings of the Lake of Bienne, Dr. Studer has met with two extreme types of human skulls—the brachycephalic and the dolichocephalic; the former (at Schaffis and Lüschery) belonging to the pure Stone period, and the latter (found at Vinelz and Sutz) to the Bronze period. The facts point to an invasion by the bronze men, involving a complete transformation of the group of domestic animals; the horse appears for the first time, and new races of sheep and dogs drive out the old forms of the Stone period. The occurrence of mesocephalic, and even much shortened, skulls in the Bronze period shows that there was no extinction of the brachycephalic race, but that the two races mixed. This mixture of races in prehistoric times increases the difficulty of tracing back the skull-forms of the present population. Dr. Studer suggests that the Rhaetian short-headed type may be referred to the old dwellers of the Stone period, in which case the prevalent dark hair, eyes, and skin of the present natives of Graübünden may recall the aspect of the older prehistoric race. There is also a large dark population about the lakes in Canton Berne.

M. VERNET has recently made a number of physiological observations on himself during eighteen ascents of high Alpine summits (between 1680 and 4638 metres in height). He finds that the strong muscular efforts made both in mounting and descending caused a rise of temperature of about 1·64° to 1·70° C. on an average; a rise in the pulse from about 75 to 83 in a minute, and an increase in the respiratory acts from about 21 to 25 in a minute. A few hours' rest after the effort ceased brought back the temperature to its normal value. Other muscular efforts, such as riding, wood-sawing or chopping, &c., had quite the same effect. The author's observations are detailed in the *Archives des Sciences*.

THE School of Anthropology, created a few years ago under the auspices of the city of Paris, has opened its 1885–86 session. The course of lectures delivered by M. de Mortillet on prehistoric anthropology will be illustrated for the first time by a series of projections. English anthropologists will learn with pleasure that M. Gabriel de Mortillet, who was one of the companions of Agassiz, has been elected representative of the Seine et Oise Department.

THE engineers of the French Service are establishing a telephonic communication between Paris and Rheims, 160 kilometres from Paris. The Paris terminus of this line will be the Exchange. A sum of one franc for each five minutes will be charged for conversation. As soon as this line is finished the work will begin of connecting Rouen with Paris (126 kilometres). Rouen has been already connected with Havre, 78 kilometres distant, by a telephonic line. Conversation between these two cities is very easily held. It is the success of this system which led to further extension on larger distances.

ON October 9, between 9 and 10 a.m., two severe shocks of earthquake were felt on the Lis Island, in the parish of Sorunda, in Sweden. In the school-house, while teaching was going on, two severe shocks were felt like two blows from an enormous hammer in the north-western corner of the building. In this corner the windows rattled, the floor swayed, and rumbling like that of distant thunder was heard. Simultaneously a great thunderstorm passed over the district, accompanied by heavy rain. It has, however, been ascertained beyond doubt that the shocks were not due to the former, as the shocks were felt by many persons out of doors. The earthquake went from west to east.

SINCE 1880, when diggings for amber were commenced under the Smaland Peninsula in East Prussia, the yield of the veins here has greatly increased. In 1864 the revenue was 1700*l*. against 25,000*l*. in 1883.

MR. WILLIAM CAMERON, F.G.S., the Singapore papers state, has been appointed *Honorary* Explorer and Geologist to the Straits Settlements. "Honorary Explorer" is a curious office, and we cannot recollect ever having heard of one before; but as Mr. Cameron, it is to be presumed, has accepted these two honorary offices, they must be of some assistance to him in his explorations in the Malay Peninsula. One so rarely hears of an Honorary Colonial governor, secretary, treasurer, or other official, that an "Honorary Colonial Explorer" is something of a *rara avis*, and as such deserves to be specially chronicled.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂), a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. C. E. McCheane; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. C. Canfor; a Mexican Deer (*Cariacus mexicanus* ♂) from Florida, presented by Mr. G. B. H. Marton; two Spotted-tailed Dasyures (*Dasyurus maculatus* ♂ ♀), three Short-headed Phalangers (*Belideus breviceps* ♂ ♂ ♀) from South Australia, presented by Sir W. C. F. Robinson, K.C.M.G.; an Osprey (*Pandion haliaetus*), captured at sea, presented by Capt. Morgan; an Alexandrine Parrakeet (*Palaeornis alexandri*) from India, presented by Mr. Chas. Williams; a Black-eyebrowed Albatross (*Diomedea melanophrys*) from False Bay, South Africa, a Vulturine Eagle (*Aquila verreauxi*) from South Africa, a Sharp-headed Lizard (*Lacerta oxycephala*) from Madeira, presented by Mr. W. Ayshford Sandford, F.Z.S.; a Black-crested Eagle (*Lophoaetus occipitalis*) from South Africa, presented by the Lady Robinson: a Rufescent Snake (*Leptodira rufescens*), a Hoary Snake (*Coronella cana*), a Keeled Euprepes (*Euprepes carinatus*), five Rough-scaled Zonures (*Zonurus corydlus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; three Grey-breasted Parrakeets (*Bolborhynchus monachus*) from South America, a Pale-headed Broadtail (*Platycercus pallidiceps*) from North-East Australia, deposited; two Lesser Vasa Parrakeets (*Coracopsis nigra*) from Madagascar, purchased.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, NOVEMBER 8–14

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 8

Sun rises, 7h. 8m.; souths, 11h. 43m. 54·1s.; sets, 16h. 20m.; decl. on meridian, 16° 43′ S.: Sidereal Time at Sunset, 19h. 32m.

Moon (two days after New) rises, 8h. 28m.; souths, 13h. 9m.; sets, 17h. 46m.; decl. on meridian, 16° 33′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	8 34	12 38	16 42	21 42 S.
Venus	11 22	14 54	18 26	26 12 S.
Mars	23 48*	7 0	14 12	13 11 N.
Jupiter	2 34	8 46	14 58	1 33 N.
Saturn	19 17*	3 25	11 33	22 18 N.

* Indicates that the rising is that of the preceding day.

Phenomena of Jupiter's Satellites

Nov.	h. m.		Nov.	h. m.	
8	4 54	II. ecl. disap.	13	4 59	I. tr. ing.
9	5 40	III. occ. reap.	13	7 16	I. tr. egr.
10	4 42	II. tr. egr.	14	4 37	I. occ. reap.
12	6 54	I. ecl. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Nov.	h.	
10	20	Venus in conjunction with and 7° 49′ south of the Moon.

OPTICAL THEORIES[1]

THE last general report on Optics which was laid before the Association was read at Dublin by the late Dr. Lloyd in the year 1834, fifty-one years ago. Since then, in 1862, Prof. Stokes dealt very completely with double refraction so far as the elastic-solid theory is concerned, and there is little to add to what he said then. In all branches of his subject the fifty-one years since Dr. Lloyd's report have been most fruitful, and in consequence the mass of papers to be dealt with has been very large.

The report is divided into four sections: the first, which is introductory, deals with the work of Green, MacCullagh, Cauchy, and Neumann, the founders of the elastic-solid theory.

In the second section the more modern writers on the elastic-

[1] Report presented to the British Association by R. T. Glazebrook, M.A., F.R.S.

solid theory are considered—De St. Venant, Sarrau, Lorenz, Stokes, Lord Rayleigh, Kirchhoff, and others.

The third section is devoted to theories in which the mutual action between the matter molecules of the transparent body and the ether is considered as the main cause of refraction, dispersion, and other phenomena.

The chief workers in this field seem to be Boussinesq, Sellmeier, Helmholtz, Lommel, Ketteler, Voigt, and, in his lectures at Baltimore, Sir W. Thomson.

The fourth and last section deals with the electro-magnetic theory of Maxwell, and the developments it has received from the hands of Helmholtz, H. A. Lorentz, Fitzgerald, J. J. Thomson, Rowland, and Glazebrook.

The report is devoted strictly to *general optical theories*. This has been required by the necessities of both space and time, and, as a consequence, the optical papers of many most distinguished workers, such as Fizeau, Jamin, and Quincke, are hardly noticed, except in so far as the results at which they have arrived bear on some point or other of the general theory. There is ample room for a report dealing with optics from an experimental standpoint which should arrange and compare the conclusions of various experimenters on debated points.

Turning, then, to the sections in order: in the second section, which deals with the elastic-solid theory, the optical properties of media are considered on the hypothesis that they arise entirely from differences in the rigidity or in the density of the ether in these media.

While the development of this theory has taught us much, we are driven to conclude that the fundamental hypothesis will not account for all the optical phenomena.

The papers of Stokes on diffraction, of L. Lorenz and Lord Rayleigh on refraction and the scattering of light by small particles, have proved conclusively that we must look to difference of density, or of apparent density, in the media to explain the phenomena, and not, as was suggested by MacCullagh and Neumann, to difference of rigidity.

With this conclusion Fresnel's hypothesis that the direction of vibration in polarised light is normal to the plane of polarisation is necessarily connected.

On the other hand, the only strict elastic-solid theory of double refraction is that of Green, and according to it, if we suppose the medium initially free from stress, the direction of vibration lies in the plane of polarisation, and even this conclusion is only arrived at by supposing certain arbitrary relations between the coefficients.

These two conclusions, then, of the elastic-solid theory are hopelessly at variance. It is true that, by supposing the medium initially to be in a state of stress, Green arrived at a second theory in agreement with his theory of reflection, but this agreement is gained by the introduction of a second set of arbitrary relations.

In connection with this point I should mention that it seems to me that Green's theory of reflection can be reconciled with experiment by adopting the suggestions of Lord Rayleigh as to the refractive index of the media for the normal waves.

The elastic-solid theory also fails to explain anomalous dispersion and metallic reflection. Cauchy's expressions for the mathematical analysis of the latter agree with experiment; but then they require that μ^2 should be complex quantity with its real part negative, and this involves the instability of the medium as regards the problem of ordinary dispersion. Cauchy's theory has been advanced by the writings of Sarrau; while the investigations of Ketteler have shown that a formula of the form—

$$\mu^2 = A + B\lambda^2 + \frac{C}{\lambda^2} + \frac{D}{\lambda^4}$$

agrees very closely with experiment.

Stokes has given us an explanation of aberration by showing us that we may suppose the earth to move through space and carry the surrounding ether with it, the ether at some distance from it being at rest; provided that the motion thus produced in the ether be irrotational, all the known phenomena of aberration will follow. And he has further shown us that any small tendency to variation from such irrotational motion will call into action the rigidity of the ether, and be propagated into space with the velocity of light. According to the views developed in these papers of Prof. Stokes, the ether may be treated as a perfect fluid for the large motions produced in it by the motion of the earth; while at the same time it has rigidity, and obeys the equations of an elastic-solid for such small motions as are involved in the passage of a wave of light.

According to the views dealt with in the second section, the ether is of the same density and rigidity in all transparent media. For such media, however, its motions are affected by the presence of the molecules of the medium. Some of the energy of the incident light may be used up in setting these matter-molecules into motion. The amount required for this depends on the nature and properties of the matter-molecules, and hence is different for different media and for waves of different length. This gives rise to reflection and refraction.

There are indications in the writings of Fresnel that he looked to some explanation himself, but it seems to be to Boussinesq that we owe the first real development of the theory.

He forms the equation of motion of the ether and matter combined on the supposition that the forces on the matter arising from the direct action of surrounding matter are owing to the smallness of the displacements negligible. He then supposes that the matter displacement U may be expanded in terms of the ether displacements u and its differential coefficients, and finally arrives at equations of the form

$$(\rho + A\rho')\frac{d^2u}{dt^2} = B\,\Delta^2 u + C\frac{d\delta}{dx}, \text{ \&c.}$$

where

$$\delta = \frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz}.$$

B and C involve the period, ρ is the density of the ether, and ρ' of the matter; and hence dispersion is accounted for. Double refraction is explained by supposing A to be a function of the direction, while B and C remain constant; and for this reasons are given, and it is shown that on certain other hypotheses this leads to Fresnel's theory. This theory deals also with the phenomena of elliptic polarisation in quartz, and of aberration.

In Boussinesq's theory the motions of the matter particles are neglected, except in so far as they act on the ether and modify its motion. Sellmeier was the first to see that reflection and refraction would be profoundly modified in the cases in which the free period of the matter particles agrees with that of the incident light, and when, therefore, the energy in that light is absorbed in setting the matter into motion. His work was continued by Helmholtz, Lommel, Ketteler, Voigt, and Sir W. Thomson.

The equations of motion employed by all these writers are the following:

$$\rho\frac{d^2u}{dt^2} = X + \bar{A} + X',$$

$$\rho'\frac{d^2U}{dt^2} = \Xi + A + \Xi'.$$

In these equations X represents the force on the ether, in the element of volume considered, arising from the surrounding ether; X', from any external impressed forces; and $\bar{A}$, from the matter; while Ξ, Ξ', and A, are the same for the matter. According to all $X = X' = 0$. We must also have $\bar{A} + A = 0$. The difference in the theories consists in the different forms given to A.

Sellmeier, Thomson, and Helmholtz put $A = \beta^2(u - U)$. Lommel puts $A = \beta^2\frac{d}{dt}(u - U)$. The results of Ketteler's theory are, except in one small and, I venture to think, non-essential point, identical with those found by putting $A = \beta^2\frac{d^2}{dt^2}(u - U)$ (Ketteler obtains his equations in a different form from the above). Voigt investigates the general form possible for A consistent with the propagation of a plane wave and the conservation of energy. He finds

$$A = \left(\alpha^2 + \beta^2\frac{d^2}{dt^2} + \gamma^2\frac{d^2}{dz^2} + \delta^2\frac{d^4}{dt^2\,dz^2}\right)(u - U).$$

For the value of X all the authors put—taking waves travelling parallel to z—

$$X = e\frac{d^2u}{dz^2};$$

while Voigt adds the term $\frac{dp}{dz}$. For Ξ all but Voigt and Thomson write—

$$\Xi = aU + b\frac{dU}{dt}.$$

Thomson objects to the term $\frac{dU}{dt}$ as involving a viscous expenditure of energy. Voigt argues, with Boussinesq that in ordinary transparent media U is so small compared with u that it may be neglected, and puts it zero everywhere.

The results of the various theories differ in the form they give for the dispersion formula. Lommel's theory has been shown by Voigt to be untenable. The theories of Helmholtz, Thomson, and Sellmeier lead, when b is small, to the same result, and give

$$\mu^2 = 1 + \frac{\beta^2 \tau^2}{\rho} \left\{ 1 + \Sigma \frac{q \tau^2}{\tau^2 - \kappa^2} \right\},$$

which Ketteler's gives

$$\mu^2 = 1 + \frac{\beta^2}{\rho} + \Sigma \frac{D}{\tau^2 - \kappa^2}.$$

τ is the period of the ether vibration, κ of the matter vibration, and q, D, &c., are functions of the constants.

Voigt's formula, since he does not consider the matter motion, is different and not so general.

With regard to these formulæ, I am not aware that Helmholtz's has been tested by comparison with experiment. Ketteler's has, and agrees excellently over a long range of values of τ.

Double refraction is generally explained by supposing β^2 to be a function of the direction; but, as Sir W. Thomson has pointed out, this involves for Helmholtz's theory—he did not, however, apply his formulæ to crystals—dispersion with double refraction. For Ketteler's theory this is not the case. μ can be a function of the direction independently of τ.

The mechanism which would make the action between the matter and ether in each element of volume a function of the acceleration is perhaps not so easy to conceive as that supposed by Helmholtz and Thomson; but still Ketteler's theory seems to overcome some of the difficulties inherent in the latter.

Either of these theories can be shown to lead to Fresnel's wave-surface, provided we do not consider it necessary that the vibrations should lie in the wave-front. The vibration, as indeed Ketteler and Boussinesq have pointed out, will be normal to the ray. In all other respects Fresnel's construction will hold.

Ketteler and Voigt have tried, without much success, to apply their theories to reflection and refraction.

Thomson, in that most valuable appendix to his Baltimore lectures, has given a complete theory. This can be readily adapted to Ketteler's theory, and the results in many points agree in a striking manner with experiments both for transparent and opaque bodies. The occurrence of a real negative value for μ^2 is explained by the supposition that the period of the incident light is higher than the highest possible mode of vibration for the matter-molecules in the medium.

The last section deals with Maxwell's electro-magnetic theory of light.

Electro-magnetic disturbance travels in air with a velocity equal to that of light; and in a double refracting medium obeys Fresnel's laws. The difficulty lies in giving a physical explanation of light motions, and of accounting for the mechanical structure of the ether required by the theory. No complete theory of dispersion has yet been given. The work of Willard Gibbs does not explain why there is no dispersion in a vacuum. The objection made to Cauchy's theory holds good. It is probable that some theory such as is developed in the third section may be successfully applied to the electro-magnetic disturbance.

The theory has the great advantage of connecting naturally with the theory of light the important electro and magneto-optical discoveries of Faraday, Kerr, Kundt, and Quincke, and to the development of this much is due to Prof. Fitzgerald. The theory of reflection and refraction as at present developed is only approximate.

ELECTROLYSIS

PROF. LODGE opened the discussion at the Aberdeen meeting of the British Association on Electrolysis by reading a paper, the notes of which have already appeared in NATURE.

Sir W. Thomson referred, in his remarks on Prof. Lodge's paper, to a matter of importance in electro-plating—viz. the selection which takes place in the electrolysis of solutions containing several salts, as, for instance, in the electrolysis of copper sulphate containing ferrous sulphate, which, when decomposed by a strong current gives a deposit containing impurities, whereas a slower decomposition yields a very pure deposit. Sir W. Thomson spoke also of the necessity for the careful investigation of those cases in which the formation of deposits between the electrodes had been observed, and it would be important to know whether deposits could be formed in the line of conduction without a nucleus at all. Such matters are of importance to physiology, indicating a possible danger in the passing of long continued currents through the human body.

Prof. Schuster explained the views propounded by Von Helmholtz in his recent papers on this subject. Helmholtz explains the phenomena of electrolysis by assuming a different attraction of different chemical elements for electricity. If this be admitted, most of the difficulties connected with the phenomena of contact electricity disappear. In electrolysis the element (say hydrogen) charged with positive electricity travels to the negative electrode and forms a coating over it. Any electromotive force, however small, is sufficient to produce this effect, as no work is done. The hydrogen does not appear as free hydrogen, however. It is only liberated when the electromotive force is sufficient to produce a transfer of the positive electricity from the hydrogen molecule to the electrode. When the dissociated elements appear in a neutral state an interchange of the electricities of the elements must have occurred before dissociation. In this way we may explain the conversion of stannic in stannous chloride, which was mentioned by Prof. Armstrong in his address. Prof. Schuster did not think that Prof. Lodge had laid sufficient stress on the fact that in very dilute solutions an ion has the same rate of transference, no matter with what element it was combined. This fact affords strong evidence in favour of the above views, from which it follows as a necessary result. Prof. Schuster also explained his own views of the discharge of electricity in gases. He believes that the phenomena present some analogy to those exhibited in electrolysis of liquids. The phenomena exhibited at the negative pole are, he thinks, due to dissociation of the compound molecule. They do not appear in the case of monatomic mercury vapour. Experiments which he hopes to conclude in the next few months will decide whether or not the law of the constancy of molecular charge holds.

The next contribution to the discussion was a paper by Dr. C. R. Alder Wright, containing an account of the nature of his investigations, conducted with the view of measuring Chemical Affinity in terms of E.M.F.

On the Sensitiveness to Light of Selenium and Sulphur Cells, by Shelford Bidwell, M.A., LL.B.—The author suggests that the operation of annealing in the making of selenium cells increases the sensitiveness to light by promoting the combination of the selenium with the metal of the electrodes, forming a selenide which completely surrounds the electrodes, and is, perhaps, diffused throughout the selenium when in a liquid condition; further, that the apparently improved conductivity of the selenium, together with the electrolytic phenomena which it exhibits, are to be accounted for by the existence of this selenide. This view finds considerable support in the fact that cells, constructed with sulphur, replacing the selenium and containing a proportion of silver sulphide, are all more or less sensitive to light, and exhibit properties of annealed selenium. The author also read a paper *On the Generation of a Voltaic Current by a Sulphur Cell with a Solid Electrolyte*, a short account of which has already appeared in NATURE (vol. xxxii. p. 345).

MOLECULAR WEIGHTS

THE discussion on the Molecular Weights of Liquids and solids was opened in Section B of the British Association by the reading of a paper by Prof. A. W. Reinold, F.R.S., the subject of which was the *Size of Molecules*. In this paper an account was given of the different lines of argument by which Sir W. Thomson has been led to form an estimate of the size of molecules. The estimate is based upon four lines of argument—the first, from the refractive dispersion of light; the second, from the phenomena of contact electricity; the third, from liquid films; and the fourth, from the kinetic theory of gases. All four agree in showing that in liquids and transparent solids the mean distance between the centre of contiguous molecules is something between 1/10th and 1/200th of a millionth of a millimetre. Recently Exner (*Monatschrift für Chemie*, vi. 244-278) has proposed another method for estimating the diameter of gaseous molecules, the results obtained by this method being slightly smaller than those deduced from the above. The author gave an account of his experiments on soap-films, conducted conjointly with Prof. Rucker (NATURE, vol. xxxii. p. 210), the results of which are not out of accord with Sir W. Thomson's estimate of the size of molecules.

On Macro-molecules, with the Determinations of the Form of some of them, by Prof. G. Johnstone Stoney, D.Sc., F.R.S.—The author suggested that the molecule of a crystal, which in all probability, consists of several chemical molecules, should be termed a macro-molecule. He then went on to show that it is possible to deduce the form of the macro-molecule from the composition of the chemical molecule ; this he illustrated by the cases of iron pyrites, boracite, and quartz.

An Approximate Determination of the Absolute Amount of the Weight of Chemical Atoms, by Prof. G. Johnstone Stoney, D.Sc., F.R.S.—The author showed that the mass of a molecule of hydrogen is a quantity of the same order as a decigramme divided by 10^{24}—*i.e.* a twenty-fourth decigrammet, which is the same as the twenty-fifth grammet. (The grammets are the decimal sub-divisions of the gramme, of which the first is the decigramme, the second the centigramme, &c.) The mass of the chemical atom of hydrogen may be taken to be half the twenty-fifth of the grammet. This value is based on the conclusion arrived at by several physicists—that the number of molecules in a cubic millimetre of a gas at ordinary temperature and pressure is somewhere about a unit eighteen (10^{18}), from which it can be shown that the number of molecules per litre must be about a unit twenty-four (10^{24}). From this, together with a knowledge of the weight of a litre of hydrogen, the above value for the mass of a molecule of hydrogen has been deduced. The mass of a molecule of hydrogen being known, it is possible now to determine approximately the masses of all other simple substances and of compounds also.

Prof. Osborne Reynolds then made a communication to the Section on the subject of *Dilatancy*, which was also read before Section A (see NATURE, vol. xxxii. p. 535).

On Physical Molecular Equivalents, by Prof. F. Guthrie, F.R.S.—The author pointed out that the *cryohydrates* are solid compounds of water and salts possessing very low melting-points, in which the mass ratios, whilst definite, are other than those of the ordinary chemical mass ratios. Another class of somewhat similar compounds has been discovered, which are quite analogous to the ordinary hydrates, and to these the name *sub cryohydrates* has been given. Metallic alloys are true homologues of the cryohydrates ; the ratios in which metals unite to form the alloy possessing the lowest melting-point are never atomic ratios, and when metals do unite in atomic ratios the alloy produced is never *eutectic, i.e.*, having a minimum solidifying point. Thus pure cast-iron is not a carbide of iron, but an *eutectic* alloy of carbon and iron. Similar hyperchemical mass ratios are found to exist amongst anhydrous salts ; when one salt fused *per se* acts as a solvent to another salt, forming *eutectic* salt alloys, similar to *eutectic* metallic alloys and the cryohydrates. The study of solution affords other instances of masses of unlike matter dealing critically with one another when not in any integral ratio of their molecular masses. Liquids, unsuspected of having chemical or physical relationships, are found, when mixed with one another, either to get warm and finally lose volume, or get cool and gain volume. In the first place chemical union is supposed to take place, and it appears certain that chloroform unites chemically with alcohol, ether with amylene, and benzene with ether, forming bodies analogous to the *sub-cryohydrates* and their prototype the *sub-cryohydrate* $C_2H_6O + 4H_2O$. The examination of those cases in which expansion and cooling results from admixture, shows that the maximum effects are produced when the admixture takes place in certain simple molecular weight ratios. This the author proposes to call the maximum molecular repulsion, which, in the case of carbon disulphide and chloroform, is attained with a mixture in which the molecular ratios are as 1 : 1. Mixtures in these proportions are found to show abnormally high vapour-tensions. And the author has made experiments which appear to show that, when carbonic acid and hydrogen are mixed, the joint volume is measurably greater than the sum.

On the Evidence Deducible from the Study of Salts, by Spencer Umfreville Pickering, M.A.—In this paper the author deals with the evidence as to the molecular weights of salts, derived from a study of the composition (1) of hydrated salts ; (2) of basic salts ; (3) of double salts. He also criticises the evidence deducible from experiments on hydration, dehydration, and the vapour tension of hydrated salts, and finally examines the conclusions drawn from the calorimetric investigations of such compounds. The conclusions arrived at by the author are that, although in a few isolated cases the molecular weights obtained would appear to be greater than the analytical results necessitate, still, in a vast majority of cases there are no grounds for multiplying these weights, and indeed there is a considerable mass of evidence in favour of adhering to the simplest possible formulæ. Such a conclusion may, at first sight, appear opposed to conclusions drawn from other sources. On the one hand the author considers it undeniable that if we succeed in determining the number of replaceable portions of the elements in any compound, we determine *ex hypothesi* the number of atoms in the molecule, that is, the molecular weight ; and whilst the data at our disposal at present are of the most meagre description, nevertheless are such as seem to point to the simplicity of these molecules. On the other hand, considerations based on the crystalline form and other physical properties of bodies force on us the conclusion that liquid and solid molecules are in all probability of a very complicated nature, certainly more complicated than gaseous molecules. Both these conclusions the author considers to be reconcileable with one another and contends that because the smallest particle of a substance which enters into a chemical reaction may be simple, there can be no reason why many of these particles may not agglomerate and act in unison as regards certain physical forces. That this agglomerate does not act as a unit towards chemical forces would simply imply that the force which unites the individuals constituting it is not chemical force, or is chemical force of such a weak nature that, in presence of the strong chemical agents we make use of, it is inappreciable. The molecule of a chemist is not necessarily identical with the molecule of the physicist.

On the Molecular Weights of Solids and Salts in Solution, by Prof. W. A. Tilden, D.Sc., F.R.S.—Accepting the conclusion that bodies in the solid state consist of units or molecules of a very complex character, and made up of a number of such smaller aggregates as compose the molecules of gases, the author is inclined to go further, and sees no reason for limiting the number of small molecules, which may thus be bound together to form a physical unit. From the law of Dulong and Petit, and of Neumann's law, it would appear that in solid elementary bodies, and in salts, &c., there is no difference between molecule and mass, and that the physical unit is the atom. The facts known concerning specific volumes and refraction equivalents support such a conclusion. According to this view solid bodies are composed of atoms, which are only distributed into molecules capable of independent existence ; when the body becomes a fluid. Such a view implies that chemical combination between atoms and the combination of molecules which ensues when a gas or liquid returns to the state of a solid are phenomena of the same nature, which agrees with the commonly recognised resemblance between the process of dissociation and those processes of fusion and evaporation. Another consequence of this view is that the idea of limited valency must be confined to gaseous substances. With regard to solutions, many facts are known, which indicate that the molecules of dissolved substances are smaller than those of solids. With regard to the question of water of crystallisation, the author does not altogether agree with the views of Dr. Nicol (see *Report on Solution*, NATURE, vol. xxxii. p. 529), but considers that the composition of the salt molecule in solution is dependent chiefly upon temperature, and in such a way that the dissolved molecule retains the same amount of water as the crystals formed at the same temperature. As the temperature rises these molecules undergo a gradual dissociation, and at a certain temperature the salt molecules lose this water and become anhydrous.

On the Molecular Constitution of a Solution of Cobaltous Chloride, by Prof. W. J. Russell, Ph.D., F.R.S.—A thin layer of cobaltous chloride gives an absorption spectrum consisting of two broad, ill-defined bands. If the chloride be mixed with potassium, sodium, or calcium chlorides, the spectrum of these mixtures, both in the solid and fused state, is different from that of cobaltous chloride, and consists essentially of four bands, two of which are marked and characteristic. This same spectrum is obtained with solutions of cobaltous chloride in absolute alcohol, in amyl alcohol, in hydrochloric acid, or in glacial acetic acid. This spectrum would, therefore, appear to be that of cobaltous chloride in an altered molecular state. The spectrum of an aqueous solution is again different, and consists of one broad band nearer to the blue end than the other bands, but the addition of cobaltous chloride to such a solution, or of such bodies as possess an affinity for water, causes a reversion of the spectrum to that of the anhydrous cobaltous chloride. Heat also produces the same effect, and it would appear from these results that the anhydrous chloride can exist in aqueous solutions. The changes in the character of the spectrum of an aqueous solution produced by heat may be explained as arising from a dissociation of some of the hydrates existing in the solution, and the production of anhydrous cobaltous chloride. Further, the fact that those solutions containing the anhydrous salt more readily transmit the blue rays and absorb the red rays, whilst those containing hydrates in solution more readity transmit the red rays, would indicate that the molecule of the hydrate is smaller than that of the anhydrous salt. The action of water on the anhydrous salt, therefore, is not to form an additive compound, but to split the molecule of the anhydrous salt and form one in which water replaces cobaltous chloride.

In the discussion which followed the reading of these papers Prof. Ramsay said that the density of a saturated vapour afforded a clue to the molecular complicity. Now while a liquid such as water or alcohol gave a saturated vapour, which at a sufficiently low temperature and corresponding low pressure had normal density, the saturated vapour of acetic acid, on the contrary, had an increasing density with fall of temperature, this density showing that the molecule has passed the stage $C_4H_8O_4$ and is on its way to $C_6H_{12}O_6$, if the results are to be explained by agglomeration of simple molecules at all.

Dr. Gladstone remarked that from the evidence of coloured salts in solution such as the sulphocyanides of cobalt, he believed that a dissolved salt might be in an anhydrous condition and might become more and more hydrated as the mass of water in its presence is increased or its temperature lowered. Evidence of other changes might also be obtained from the colour of solutions. He did not think that the refraction of light by a body is often likely to tell anything about its molecular volume; but in the case of the polymeric olefines, C_nH_{2n}, the specific refraction and dispersion will probably decrease considerably as the value of n becomes greater, on account of the increasing proportion o carbon in the normal condition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following have been appointed examiners for the ensuing year:—Physics and Chemistry: Prof. Schuster, F.R.S., and Mr. R. T. Glazebrook, F.R.S.; Chemistry: Messrs. A. Scott and W. J. Sell; Mineralogy: Prof. Liveing; Geology: Messrs. J. J. H. Teall and J. E. Marr; Botany: Messrs. W. Gardiner and H. M. Ward; Human Anatomy: Profs. A. Macalister, F.R.S., and G. D. Thane; Comparative Anatomy: Mr. A. Sedgwick; Physiology: Prof. Michael Foster, Sec. R.S., and Mr. A. S. Lea; Pharmacy and Pharmaceutical Chemistry: Prof. Wyndham Dunstan.

Mr. F. H. Neville, Sidney Sussex College, is appointed as teacher of chemistry with reference to certificates for M.B.

In the late Higher Local Examinations the arithmetic and Euclid were fairly well done.

In Algebra and Trigonometry the cases of gross failure were fewer, while the work of the better candidates was not so good as last year.

Considerable care had been taken to apprehend the facts of Mechanics, but some candidates merely stated a result when asked to "prove" or "establish" it; and when asked to draw inferences by means of the laws of motion, they drew inferences from quite other considerations. A certain amount of knowledge of Descriptive Astronomy was shown by some of the candidates: two of the twenty-two obtained more than half marks.

Only four candidates took the paper in Differential and Integral Calculus. Two of them showed a sound knowledge of the early definitions and rules for differentiation; the other two (who alone attempted the last eight questions) were less successful on the whole, and had confused ideas on the elementary parts of the subject. No marks were obtained in Integral Calculus.

In the Elementary Natural Science paper the work was as a whole extremely poor, notably in Chemistry.

In Physics the candidates seemed to possess very little power of giving concise and definite answers. The attempts to describe experiments and experimental proofs of physical laws were remarkably weak, and might be described as a mere echo of experimental lectures only partially understood; they showed none of the results that might fairly be expected from a careful consideration of those facts and principles which were clearly within the candidates' reading.

In Physical Geography and Geology most of the papers were good, but none excellent.

In Physiology the answers were on the whole satisfactory, while three or four papers showed that the writers had gained a very creditable acquaintance with the subject.

In Zoology most of the papers were far from creditable, and exhibited but little real or intelligent knowledge. The answers to the practical questions were uniformly bad.

In Botany the candidates displayed but little knowledge of what is meant by the terms "growth," and "collateral," and no one gave a good description of the method of measuring growth. The plant given for description was fairly well described, but the floral diagram was in many cases imperfect. The germination of a seed was not well described. Several students described *Penicillium*, *Mucor*, and *Agaricus*, as parasites.

At Gonville and Caius College an examination will be held on December 8 for open scholarships and exhibitions. Natural Science candidates, who must be under nineteen years of age, will be examined in Physics, Chemistry, Biology, and Animal Physiology; proficiency will be expected in at least two of these subjects, of which chemistry must be one. Further information will be given by the tutors.

At the annual election on November 2 at St. John's College, the following were elected to Fellowships:—A. Harker, M.A., Eighth Wrangler 1882, First Class Nat. Sciences Tripos (Physics) 1883, Woodwardian Demonstrator in Geology; D. W. Samways, M.A. (D.Sc. London), First Class (with distinction in Physics) Nat. Sciences Tripos, 1881, University Extension Lectures in Physics and Physiology; W. H. Bennett, M.A. (M.A. London, Mathematics), First Class Theological Tripos 1882, Tyrwhitt Hebrew Scholar; W. Bateson, B.A., First Class Nat. Sciences Tripos (Zoology) 1883, Assistant Demonstrator of Animal Morphology; R. W. Hogg, B.A., Sixth Wrangler 1883, First Class, Part III., Mathematical Tripos, 1884.

THE annual election of Fellows of St. John's College, Cambridge, took place on Monday, when the five vacancies were filled up by the election of the following graduates of the College:—

(1) A. Harker, M.A., 8th Wrangler, 1882—First-class Natural Sciences Tripos, Part I., June, 1882, First-class Natural Sciences Tripos, Part II., June, 1883, for Physics, Woodwardian Demonstrator in Geology.

(2) D. W. Samways, M.A., D.Sc. London—First-class Natural Sciences Tripos, 1881, distinguished in Physics.

(3) W. H. Bennett, M.A.

(4) W. Bateson, B.A.—First-class Natural Sciences Tripos, Part I., June, 1882, and First-class Natural Sciences Tripos, Part II., June, 1883, for Zoology and Comparative Anatomy, Assistant Demonstrator in Animal Morphology.

(5) R. W. Hogg, B.A., 6th Wrangler, June, 1883, and in the first division Mathematical Tripos, Part III., January, 1884.

PRELIMINARY SCIENTIFIC EXAMINATION OF THE UNIVERSITY OF LONDON.—The following statistics of the Preliminary Scientific Examination for the degree in Medicine of the University of London are of importance as conclusively proving that those members of the medical profession who so urgently declare this examination to be too severe are entirely misinformed. At the examination in last July there passed from all parts of the United Kingdom 159 candidates. Nearly an equal number were rejected; but that this is owing to the fact that the candidates had not sought the usual and proper methods of preparation, and not to the fact that the examination is a specially difficult one, is proved by the following important facts:—63 candidates entered for this examination, stating that they had prepared for the examination wholly or in part at University College, London. Of these 63 candidates 52 passed, and several took honours. Thus less than one-fifth were rejected of those candidates who attended the carefully-organised teaching of University College. This is an exceedingly small proportion of failures for any pass examination. From other London colleges a much smaller number of successful candidates is recorded. The largest number after the University College list is that of St. Bartholomew's Medical School. Instead of 52 we fine here, however, 16. Then come Guy's, St. Thomas's, and King's College, each with 11, London Hospital with 5, St. Mary's with 3, and St. George's, Middlesex, and Charing Cross, each with 1. These figures lend strong support to the suggestion which has so often been made, that the Hospital schools would do well to cease the attempt to teach purely scientific subjects, and should recognise the Faculty of Science of University College as the common preliminary scientific school for all London hospitals. The students themselves, it is obvious, already take this view. Of the 52 successful candidates belonging to the Faculty of Science of University College only 12 have entered the Faculty of Medicine of that institution. The remaining 40 have selected their hospitals without prejudice. Several have obtained entrance scholarships at the large London hospitals.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale de Belgique, July.—Observations on the planets Jupiter and Venus, made at the Astronomic Institute of Ongrée, by M. L. de Ball.—On the eurites, or older rhyolithic formations of Grand-Manil, by M. Ch. de la Vallée Poussin.—On the pretended bacterian origin of diastase, by M. Emile Laurent.—On the organic structure and growth of *Phycomyces nitens*, by the same author.—On the Devonian limestones of coral origin and their distribution throughout the palæozoic formations of Belgium, by M. E. Dupont.—Theory of elliptic functions: Hermite's equation, by M. J. A. Martius da Silva.—The philosophic system of the Bhagavadgîta, by M. Le Roy.—An unpublished Latin inscription referring to T. Desticius Severus, Procurator of Gallia Belgica, by M. Bartolini.—Origin of the Flemish inhabitants of Belgium, with preliminary remarks on the Suevi of Flanders, by M. Alph. Wauters.

August.—Fresh researches on the apparent enlargement of the sun, moon, and stars at the horizon, by M. Paul Stroobant.—Reaction of the sulphate of barium and the carbonate of sodium under the influence of pressure, by M. W. Spring.—Note on the lower Devonian rocks of Belgium: the pudding system of Weris and its transformation, by M. E. Dupont.—Experimental researches on the sense of sight in insects: Do insects distinguish the outlines of objects? by M. F. Plateau.—Determination of an empirical relation connecting the tension of vapour with the coefficient of internal friction in fluids, by M. P. De Heen.—The eurites of Grand-Manil (continued), by M. Ch. de la Vallée Poussin.—Biographical notices of Mathieu de Morgues and Philippe Chifflet, by M. Auguste Castan.—On the old Persian, Hindu, and Chinese literatures, by M. Ch. de Harlez.—Note on the domain of the Aduaticæ, and on some other questions of ancient Belgian geography, by M. L. Vanderkindere.

Schriften der Physikalisch-Okonomischen Gesellschaft zu Königsberg i. Pr., 25th year (1884).—1st and 2nd parts.—Memorial address on Oswald Heer (with list of works) by A. Jentzsch.—On the development of the oil-vessels in the fruits of Umbelliferæ, by J. Lange.—Festival address on the centenary of Bessel's birth, by I. Franz.—Correction of Sanio's memoir on the numerical relations of the flora of Prussia, by J. Abromeit.—Reports on local botany, museum collections, &c.

SOCIETIES AND ACADEMIES

London

Mineralogical Society, October 20.—The Rev. Prof. Bonney, President, in the chair.—Messrs. F. R. W. Daw, John Daw, Jun., G. F. Kung, and C. C. Ross, M.P., were elected members. The following were elected officers and Council for the ensuing year:—President: L. Fletcher, F.G.S.; Vice-Presidents: Rev. S. Haughton, F.R.S., Rev. Prof. T. G. Bonney, F.R.S.; Council: C. A. Burghardt, LL.D., A. Geikie, F.R.S., Rev. H. Gurney, M.A., Hugo Müller, F.R.S., Rev. W. W. Peyton; Treasurer: R. P. Greg, F.G.S.; General Secretary: R. H. Scott, F.R.S.; Foreign Secretary: T. Davies, F.G.S.; Auditors: B. Kitto, F.G.S., F. W. Rudler, F.G.S. The Secretary read the following Report of Council:—The balance-sheet for the year 1884, which appeared in No. 28 of the *Journal*, showed that the finances of the Society were in a healthy condition, the excess of assets over liabilities amounting to 215*l*. 12*s*. 4*d*. The number of Members and Associates elected during the year has been seven, and the number of resignations five, while the names of four Members and one Associate have been removed from the list for non-payment of subscriptions for three years. The Council regret that they have to report also the death of Alexander Murray, C.M.G., of St. John's, Newfoundland. Three meetings have taken place since the last anniversary: those in December and March were held in the Museum of Economic Geology, by kind permission of the Director-General of the Survey; the third was held in Glasgow in the month of June, in the rooms of the Philosophical Society. This, the second Scottish meeting, was, like its predecessor in 1884, a decided success. Three parts of the *Journal* have been issued during the year. Among their contents the Council would especially draw attention to Mr. Miers' contributions, including his careful index to the mineralogical literature of the year. Herr Sjögren's paper on graphite also deserves notice; it is a translation from the Swedish, as it originally appeared in the *Forhandlingar* of the Stockholm Academy. In conclusion the Council would only remind the members that it is very desirable that they should co-operate actively in the working of the Society by the contribution of papers to be read at its meetings and published in its *Journal*. It is by such co-operation alone that the Society can be maintained in a state of vigorous activity. The President then delivered his address, which will appear in the *Journal*. Prof. Bonney then vacated the chair, which was taken by the newly-elected President, Mr. Fletcher, and the following papers were read:—H. A. Miers, on a crystal of orthoclase.—R. H. Solly, notes from the Mineralogical Laboratory, Cambridge, being an account of the following minerals:—garnet, axinite, asbestus, and semiopal from the Mid-Devon Copper Mine, apatite or Francolite from the Levant Mine, and Fluor Spar from Holmbush.—Dr. Max Schuster, results of the crystallographic study of danburite.—W. E. Dawson, analysis of a supposed new chromate of lead from the Transvaal.—Prof. Lewis exhibited a fine crystal of colemanite; and Mr. Fletcher exhibited some Roman coins found near Chester and presenting crystals of cuprite.

Sydney

Linnean Society of New South Wales, August 26.—Prof. W. J. Stephens, M.A., F.G.S., President, in the chair.—The following papers were read:—List of plants in use by the natives of the Maclay Coast, New Guinea, by N. de Miklouho-Maclay, with botanical remarks by Baron Ferd. von Müller, K.C.M.G., &c. Baron Maclay in this paper gives (1) a list of the plants used as food, dividing them into those cultivated and those growing wild; (2) those cultivated as stimulants or for medicine; (3) those useful in various ways for household purposes; and (4) those introduced since 1871. An Appendix by Baron Müller gives an account of some of the plants mentioned by Baron Maclay and gives a description of a new species named *Bassia maclayana*.—Catalogue of the Coleoptera of Australia, by George Masters. This is the first of a series of papers intended by Mr. Masters to make a complete and perfect list of all the known species of Coleoptera in Australia. The present part comprises the Cicindelidæ and Carabidæ, and numbers 950 species.—Descriptions of three new Port Jackson fishes, by J. Douglas-Ogilby, Assistant Zoologist, Australian Museum. The three species here described are *Scyllium anale*, *Heliastes immaculatus*, and *Pempheris lineatus*.—Mr. Macleay exhibited a section of a branch of an orange tree completely perforated by the larva of a longicorn beetle. Also three specimens of a beetle found in the perforated wood. The exhibit had been sent by Mr. M. de Meyrick, a member of the Society, who stated that many orange trees had suffered in the same way in the neighbourhood of Penrith. Mr. Macleay said the injury was caused by the larva of *Monohammus fistulator*, a grub destructive to all kinds of fruit trees, but, as far as his experience went, its ravages were confined to old or decaying trees, and it would be interesting to know if in any instance it had been found to attack young and vigorous plants. The accompanying beetles were heteromerous insects of the genus *Amarygmus*, and were not in any way the cause of the injury to the tree.—Mr. A. Sidney Olliff exhibited specimens and sketches of *Cryptommatus jansoni*, Matt., a curious beetle which was found under the fur of the common rat in Tasmania, and said that he believed new and interesting species with similar habits might be found in Australia if the smaller mammals were examined when freshly killed. Two allied species were known from Peru, one of which was found in the fur, and also in the nests, of mice. The specimens exhibited were captured by Mr. A. Simson and had been obtained from Mr. Morton, of the Hobart Museum.

PARIS

Academy of Sciences, October 26.—M. Bouley, President, in the chair.—A means of preventing rabies from the bite of a mad dog, by M. L. Pasteur. After almost endless experiments the author announces that he has at last succeeded in obtaining a practical and prompt prophylactic remedy, which has already proved sufficiently efficacious in the case of dogs, to justify the belief in its general efficacy when applied to all animals, including man himself. A full account of the process will be found at p. 1 of this week's NATURE.—Direct fixation of free atmospheric nitrogen in plants through the agency of certain argillaceous clays, by M. Berthelot. Some years ago the author found that to atmospheric electricity was largely due the attraction of free nitrogen to the immediate elements of vegetable organisms. After fresh experiments conducted for two years at the Meudon station for vegetable chemistry, he has now discovered a new and perhaps a more general cause of this arrestation in the silent but incessant action of argillaceous clays and of the microscopic organisms contained in them. In this memoir he gives the results of over 500 analyses of four different clays constituting five distinct but simultaneous series of experiments in a closed chamber, in a field under shelter, on top of a tower 28 metres high without shelter, in hermetically sealed flasks, and lastly in soil artificially sterilised.—Note on the Cynthiadæ of the French seaboard, by MM. H. de Lacaze-Duthiers and Yves Delages. In the present paper the authors restrict their remarks to the typical *Cynthia morus*, a characteristic group of simple ascidians occurring in the English Channel, in the Atlantic, and in the Mediterranean. The several varieties are determined and the anatomy of the whole group described in detail.—Note respecting some recent communications on waterspouts, by M. Faye. The author's remarks refer to the report issued by the United States Army Signal Service on the thirteen tornadoes of May 29–30, 1879, the most complete and elaborate account of these phenomena hitherto published.—Experiments on the transmission of force by electricity between Paris and Creil, by M. Marcel Deprez. These costly experiments, begun on October 17, 1884, and carried out with the aid of MM. Rothschild, have so far proved very satisfactory. In a future communication complete tables are promised of all the electric and mechanical data of the experiments hitherto made both by the author and by M. Collignon.—On the propagation of motion in bodies, and especially in perfect gases, by M. Hugoniot.—Note on a new process for making hydrogen gas, by MM. Felix Hembert and Henry. By this simple and economic process hydrogen gas available for numerous combinations applicable to the arts and industries may be produced at the rate of 0·015 franc the cubic metre.—Discovery of a new planet (No. 25*a*, of 13th magnitude) at the Observatory of Nice, by M. Perrotin.—Remarks on the new star in the nebula of Andromeda, one illustration, by M. E. L. Trouvelot. This new star A, as well as the already discovered B, would appear to form part not of the nebula itself, but of the Milky Way. — Application of M. Lœwy's new methods for determining the absolute co-ordinates of the circumpolar stars, without the necessity of ascertaining the instrumental constants (polar distances), by M. Henri Renan.—Questions relating to a bundle of plane cubic figures (continued), by M. P. H. Shoute.—On birational plane geometrical transformations, by Mr. G. B. Guccia.—General differential equations reducible to quadratures, by M. Wladimir Maximowitch.—Note on a new absorption spectroscope, by M. Maurice de Thierry. This apparatus enables the observer to study fluids under a thickness of 3 to 10 metres, and to detect the presence of oxyhemoglobine in a liquid containing not more than 1-5,000,000th of that substance. It is an instrument of extreme precision, capable of rendering great services to forensic medicine, physics, and biological chemistry, by facilitating the study of the absorption spectra of fluids examined under a great thickness.—Note on a new neutral carbonate of magnesia, by M. R. Engel. This is an anhydrous carbonate absolutely different both from the natural neutral carbonate (CO_3Mg) and from the crystallised and anhydrous neutral carbonate artificially obtained by M. de Senarmont.—On the volatile property of the mixed organic compounds, by M. Louis Henry.—Note on the zymotic properties of four kinds of virus: those of the spleen, of puerperal septicemia, of gangrenous septicemia, and of the symptomatic charbon of the ox, by M. S. Arloing.—On the existence of two kinds of sensibility to light—the sense of colour and of form, by M. H. Parniaud.—On the physiological action of the sodic sulpho-conjugate of rocellic acid, by MM. P. Cazeneuve and R. Lépine.—On the circulation of the blood in the nerve-cells of the intervertebral ganglia, by M. A. Adamkiewicz.—On the method of distribution of certain sympathetic intra-cranial chords, and on the existence of a sympathetic root of the ciliary ganglion in the goose, by M. F. Rochas.—On the development of the nematodes (second note), by M. Paul Hallez.—Fresh researches on the influence of shocks on the egg-germ of the hen during the period between laying and hatching, by M. Dareste. Theoretical researches on the distribution of heat on the surface of the globe, by M. Alfred Angot.—On the varying dates of the vintage season in France since the year 1236, by M. Alfred Angot.—Application of thermo-chemistry to the explanation of geological phenomena: carbonate of zinc, by M. Dieulafait.—On the green luminous ray observed at sunset in the Indian Ocean, by M. Trève.—Remarks on M. G. Arth's recent note regarding the action of the nitrate of anhydrous ammoniacal ammonia on some metals, by M. Ed. Divers.

STOCKHOLM

Academy of Sciences, October 14.—The following papers were presented for insertion in the Society's *Journal*:—A monographic revision and synopsis of the Microceridæ and Protomantinidæ, by Prof. Aurivillius.—Lois de l'équilibre chimique dans l'état dilué, gazeux ou dissous, by M. T. H. vant Hoff.—On the distribution of the sexes in *Acer platanoides*, L., and in some other species of Acer, by Prof. V. Wittrock.—*Codiolum polyrhizum*, n.sp., a contribution to the knowledge of Codiolum A. Braun, by Herr G. Lagerheim.—Contributions to the knowledge of the specific warmth of some minerals, by Dr. W. Öberg.—On Petrus de Dacia, by Dr. G. Eneström.—The osteology and exterior conformation of Sowerby's whale (*Micropteron bidens*, Sow.), by Dr. Carl Aurivillius.—Researches on remains of the limbs in the Ophidians, by Miss Albertina Carlsson.—Investigations into some sources of error in measuring the amount of the rainfall, by Dr. S. A. Hjeltström.

CONTENTS

THURSDAY, NOVEMBER 12, 1885

THE INTERNATIONAL SANITARY CONFERENCE OF ROME, 1885

THE first volume of the Proceedings of the International Sanitary Conference of Rome has been issued just at the time when the question of the re-assembling of the Conference is a matter of diplomatic discussion. The Roman Conference of this year was brought together by the Italian Government because it was felt that, after the cholera experience of 1883 in Egypt and of 1884 in Southern Europe, advance might be made in determining the bases of an International Code as to quarantine or other preventive measures. The previous Conference had been held at Vienna in 1874, and the conclusions then arrived at had indicated substantial progress since the preceding meeting at Constantinople in 1866. Under these circumstances nearly all civilised Governments responded to the appeal of Italy, and five delegates were deputed to represent this country. Two of these, Sir W. Guyer Hunter and Dr. Thorne Thorne, acted with the British Ambassador at Rome for Great Britain, and Sir Joseph Fayrer with Dr. Timothy Lewis went as representatives of our Indian Empire. Soon after the opening proceedings, a Technical Commission, consisting of the medical delegates, was formed, and it is essentially with the proceedings of that Commission that the volume referred to has to do.

With the ready assent of Dr. Koch, the Commission decided at the onset not to discuss scientific questions bearing upon etiology or otherwise, and the series of resolutions arrived at deal almost exclusively with the measures which are deemed necessary to prevent the spread of cholera in Europe. Perusal of the proceedings at once shows that the Powers bordering on the Mediterranean had one principal object in view. They were convinced that shipping passing from India *viâ* the Suez Canal constituted the great source of danger to ports on the basin of the Mediterranean; they knew that the sanitary state of the majority of those ports could not withstand the importation of infection; hence, cost what it might to other nations, they were determined to place restrictions upon shipping passing through the canal. It is true that the utter failure of quarantine measures had once more been abundantly shown during the 1884 epidemic, and for this reason the Commission decided to drop the word quarantine altogether; and they proposed, instead of the ten days' quarantine which had been sanctioned at Vienna, to require a detention of five days for the purposes of "observation." But, as was pointed out by the English delegates, this was quarantine pure and simple, for it involved the disembarkation of all on board vessels which might be regarded as infected by some internationally appointed officer, and the detention of men, women, and children in the filthy lazarets of the Red Sea shores for as many consecutive periods of five days as the officer in question might choose to dictate, so long as he could regard any one amongst the persons thus isolated as having suffered from symptoms which in his opinion resembled cholera. As regards European protection, it was also contended that such a measure was unnecessary in the case of British ships, and the Commission were twice challenged to give a single instance in which cholera had been brought into the continent of Europe by means of a British ship coming from India. And if it was unnecessary, it was contended that, provided British ships touched at no ports on their way home, they should be allowed the free passage of the Suez Canal as of an ordinary arm of the sea.

But quarantine restrictions were not only held to be unnecessary, they were also shown to be distinctly mischievous in so far as they led the inhabitants of threatened countries to rely on Government measures of that description instead of adopting measures of sanitation which constituted the true remedy against cholera spread. And here the experience of England was shown to be strikingly opposed to quarantine. It is now some ten years since England, adopting one of the alternative measures sanctioned at Vienna, decided that since quarantine must always fail, the country would place its trust in an inspection of in-coming vessels, together with the immediate isolation of the sick in hospital, and in securing such improvement in the sanitary state of the country as would tend to remove the conditions favourable to the diffusion of cholera if imported. And Dr. Thorne Thorne, whilst pointing out in detail that during that period of ten years our sanitary authorities had spent some 27,250,000*l.* in large public health works and that this had in truth been a remunerative expenditure by reason of the saving of life which had followed it, asked what country had shown a greater proof of the value it set on human life than England had, and contended that it would be an unfortunate day if we were to replace such a system by the imposition of a five days' quarantine. Indian statistics proving similar results were also brought forward by Sir Joseph Fayrer, and they must be regarded as unanswerable.

In short, the English delegates contended that we must look, above all, to improved sanitation in order to get rid of the danger of cholera; that countries which are taught to rely on the false security of quarantine measures and sanitary cordons will not at the same time spend their money on sanitation; and that the very countries which had fitted themselves to resist cholera by making real and substantial progress as regards sanitary improvements, and had thus effected a saving in life from infectious diseases, were those which had determined to place little or no trust in measures of quarantine.

Compared with the resolutions of the Vienna Conference, the conclusions arrived at in Rome do in many respects admittedly afford evidence of considerable advance, but they are vitiated by the initial error of trusting to modified quarantine restrictions, instead of boldly facing the need for improved sanitation. As yet these conclusions are those of the Technical Commission only, and it remains to be seen whether, since the English delegates are opposed to their colleagues on a matter of such vital principle, any object will be gained by the re-assembling of the Plenary Conference, to discuss the recommendations made by the Commission.

"EVOLUTION WITHOUT NATURAL SELECTION"

Evolution without Natural Selection; or, The Segregation of Species without the Aid of the Darwinian Hypothesis. By Charles Dixon. (London: R. H. Porter, 1885.)

THE title of this little book is misleading. Far from offering any account of evolution without natural selection, the author habitually ascribes to natural selection the lion's share of the work, only reserving a few odds and ends of small detail as results ascribed by him to other agencies. Such odds and ends have reference almost exclusively to minute differences of coloration in allied species of birds—the argument being that these differences are too minute to count for anything in the struggle for existence, and therefore cannot have been due to survival of the fittest. Now, although Mr. Dixon has presented in a brief and very readable form a considerable number of most interesting facts upon this head, they cannot be said to have any bearing upon the Darwinian hypothesis. For even if it were conceded, for the sake of argument, that all the cases given of slight variation in allied species are without utilitarian significance (although this would be a large concession), we should still be well within the four corners of Darwinism. It is the very essence of the Darwinian hypothesis that it only seeks to explain the apparently purposive variations, or variations of an adaptive kind; and, therefore, if any variations are taken to be non-adaptive, *ex hypothesi* they cannot have been due to natural selection. But as such variations are, even upon the showing of our author himself, for the most part rare and always trivial, they may be freely presented to the anti-Darwinians without any loss to Darwinism. Indeed, Mr. Darwin himself has clearly recognised the occurrence of such trivial specific characters, and observes that if they are "really of no considerable importance in the struggle for life, they could not be modified or formed through natural selection." But it is no part of the theory of natural selection that it should necessarily occupy the whole field of possible causation in the genesis of species. It is surely enough if it be taken to explain all cases of *adaptation;* and this, if we understand him aright, Mr. Dixon is prepared to allow. Thus, for example, he says:—"We can therefore understand how the modifications which many species have undergone, through climatic and other causes, have been taken advantage of *when they began to be of service;* although at the time the modifications took place they were not of the slightest use!" The note of admiration here seems to imply, in accordance with the whole tone of his book, that the writer considers this view to be in some way an important emendation of Darwinism. But, in point of fact, it is Darwinism pure and simple. For Darwin is most express in affirming that natural selection cannot be supposed the original cause of variation, being only called into play when the variations, as Mr. Dixon says, begin to be of service. What these original causes of variation may be is a distinct question, and one which it remains for the future to answer. For, as we shall immediately proceed to show, Mr. Dixon has not been successful in furthering the solution.

The influence on which he chiefly relies is that of isolation, and he has gathered a number of interesting facts whereby to justify his opinion. It is needless to say that this opinion also is quite in harmony with Darwinian teaching; for when a section of a species is geographically isolated, the constituent members of it are virtually confined to a world of their own whereon to begin a new course of history, and being thus cut off from interbreeding with the main stock, there is nothing remarkable in the fact that, under such circumstances and in some cases, the history of the isolated section should not run perfectly parallel with that of the main stock. This, indeed, is Mr. Dixon's own view, and we should have no criticism to offer upon it, if, on the one hand, he did not present it as anti-Darwinian, and if on the other hand he had been more clear in distinguishing between a condition and a cause. He everywhere speaks of isolation as the cause of minute specific characters; whereas it is obvious that at best it can only be the condition to the operation of causes, the nature of which it apparently does not occur to him to suggest.

Another agency invoked by the writer as a direct cause of variation is climate. But here again his views cannot be said to be anti-Darwinian, save in so far as they appear to err on the side of exaggeration. For even Mr. Spencer—who, by the way, ought to have been mentioned by Mr. Dixon as having long ago argued in favour of such direct causes of variation—would scarcely go so far as to attribute to climatic influences variations of a protective kind. This, however, is done by Mr. Dixon; but he maintains a judicious silence upon the closely-allied topic of mimicry. Yet such remarks as the following apply with even more force to the facts of mimicry than to those of protection:—"If the colour was donned from protective motives, to escape some special enemy, it seems impossible not to believe that the species would have become exterminated long before the protective colour reached a beneficial degree of development." Does Mr. Dixon believe that the exquisite details of form and colour whereby an insect is made to resemble a leaf can reasonably be ascribed to climatic influences? If not, what becomes of his argument touching the much less remarkable cases of protective colouring?

There still remains one other criticism of a general kind which it seems impossible to avoid making. On p. 7 it is said: "Natural Selection is probably the most potent agent in the evolution of new species only at such times when the earth is undergoing violent changes. . . . We can conceive how, as soon as violent changes once more pervade the world, the struggle for life will be infinitely greater than it is now. Then species will be matched against species, race against parent form, or race against race; all Nature will be thrown into a kind of chaos; and then Natural Selection will adjust the disordered balance," &c., &c.

Now, this passage, which appears to be intended as conciliatory to Darwinism, is the only really anti-Darwinian passage in the essay. For not only are the views expressed by it in direct contradiction to the now universally-accepted teaching of uniformitarianism, but they equally run counter to the emphatic contention of Darwin, that the great merit of his theory consists in its agreement with that teaching. Not in chaos or in cataclysm is the influence of natural selection to be sought, but in forest and in field, in river, lake, and sea, where all may seem most orderly and eloquent of peace.

But although we are thus unable to commend Mr. Dixon's philosophical views on topics connected with natural history, we should be sorry to take leave of his work without explicitly stating what has already been implied—namely, that his facts are better than his theories. On this account we consider that his essay well repays perusal, and therefore recommend it to the notice of zoologists. GEORGE J. ROMANES

FORESTRY IN POLAND

Forests and Forestry in Poland, Lithuania, the Ukraine, and the Baltic Provinces of Russia. With Notices of the Export of Timber from Memel, Dantzig, and Riga. Compiled by John Croumbie Brown, LL.D., &c. (Edinburgh; Oliver and Boyd. London: Simpkin, Marshall, and Co., and William Rider and Son, 1885.)

THIS is another contribution of Dr. Brown's to the subject of forestry and to the furtherance of the formation of the Museum and School of Forestry in Edinburgh, which, it was thought, might be the outcome of the Forestry Exhibition held in the Scotch capital last year. The consideration of the establishment of a forest school has since occupied a wider range of thought, consequent upon the action of Sir John Lubbock in the House of Commons, and in connection with this Dr. Brown's latest volume will probably be of some interest in showing what is effected in forest matters in countries somewhat beyond the track of the ordinary English traveller, notwithstanding that Dr. Brown has given us similar books to the present on the forests of Norway, Northern Russia, the Ural Mountains, &c.

The present book commences with a very readable comparison of the facilities of travelling in Poland, Lithuania, Courland, Estonia, and Livonia some forty years since and at the present time.

In the first chapter the character of the country along the railway for some 200 miles from St. Petersburg towards Poland is described as a dead level of marshes and bogs; such dry land as there is being to some extent covered with trees probably of no great age, "apparently," Dr. Brown says, "the scraggy representatives of extensive forests of a former day." Nowhere are such forests as may be seen in travelling in the Governments of Olonetz and Archangel in Northern Russia, and of Moscow, Orel, and others in Central Russia.

Entering Poland at Kovna, about 200 miles from Dunsburg, and advancing through the eastern portion of that country, Dr. Brown says the traveller remarks that agriculture appears to be carried on with a more scientific character than in the lands through which he has been passing. Agriculture seems also to be more remunerative; the crops are thicker. The fields are sown with wheat, whereas to the north of Kovna barley, oats, and flax alone are cultivated. All the more valuable cereals seem to flourish in Poland, and in passing through this district there is produced an impression that the soil is more productive than it is further to the north; that the climate must be more equable; and the superficial aspect of the land being more undulating, and at the same time more thickly wooded; that as an agricultural district it must be at least 50 per cent. superior to the Governments of St. Petersburg and of Pskoff. In Poland both wheat and wool are raised for exportation. Large crops of potatoes are grown for the production of spirits by distillation, and beetroot for the manufacture of sugar; and wood for building purposes is exported largely. The Scotch fir (*Pinus sylvestris*) and the oak (*Quercus Robur*) are of very superior quality.

The trees in this district are described as being different in character from those of the region traversed in coming hither. In the earlier stages of the journey they consisted almost exclusively of firs, birches, and willows, while around Berdicheff in Poland the woods are composed in a great measure of oaks, elms, and chestnuts.

Dr. Brown's second chapter is devoted to forest exploitation, and the third chapter to the important subjects of area, distribution, management, and produce of forests. The information under these heads is, however, to some extent technical and statistical. Some interesting facts are quoted regarding what may be called bye-products of the forest, such, for instance, as honey, which is collected by the bees largely from the flowers of the lime-tree, as well as from the thyme, hyssop, and buckwheat.

Regarding the schools of forestry in Poland, the most important arrangements for the study of forest science and economy by forest officials are at Novoi-Alexandria. Of these arrangements details are given, from which it seems that the institute is ranked as a college of the first class with two sections—one devoted to the study of rural economy and agriculture, the other to the study of forest science and forestry, with a farm, forest, and an extensive domain attached to it, the whole being placed under the Minister of Public Instruction at Warsaw. The staff of officials includes a director, inspector, five professors, eight tutors and three teachers, a laboratory superintendent, a mechanic, foreman of the workshop, land steward or manager of the estate, gardener and assistant, surgeon, secretary, book-keeper, and a superintendent of buildings. No professor can hold two chairs, and any of them after twenty-five years may be again and again reappointed for successive terms of five years each. A Board of Management, consisting of the director, inspector, and two professors, has the charge of expenditure to the amount of 300 roubles, to be sanctioned by the director; the expenditure of sums between 1000 and 5000 roubles requires the sanction of the Council; and the expenditure of sums above this amount that of the Ministry. The course of instruction embraces a very wide range of subjects. The instruction is given in the Russian language. Each professor and tutor is required to give six lectures a week, and teachers to spend twelve hours a week in class duties.

In the second part of Dr. Brown's book, which is devoted to Lithuania, the chapters are apportioned to considerations of the people, the aspects of the country, forests of the Dnieper, while Parts III., IV., and V. are respectively given up to the Ukraine, the timber exports of the Baltic, and the Baltic provinces of Russia.

OUR BOOK SHELF

Elementary Mechanics. By O. J. Lodge. (London and Edinburgh: Chambers, 1885.)

THIS is a revised edition of Prof. Lodge's Text-Book:—not much altered, so far as we can see even by the help of the rapid yet searching stereoscopic squinting, from the former edition. Why a writer, who begins by acknowledging his indebtedness to the really scientific works of Thomson and Tait, Clerk-Maxwell, and Clifford, should make frequent references to the merely "popular" and singularly loose *brochures* of Deschanel and Ganot, is a question more easily asked than answered. But it is totally unintelligible to us that, having begun with classical works, he should proceed to "recommend real students to read one or other" of these poor compilations. Was it not Horace Smith who said:—

> "Is there such scanty store of standard works,
> That students must be fed on foreign trash?"

But Prof. Lodge's own standard is far above that of the books to which he, unfortunately and unaccountably, refers his "real students." His work is a curious one. There is scarcely a trace of the dogmatism which is asserted to be so natural to the *genus* Professor! The author seems to place himself on the same level with his reader, and anxiously to seek for confirmation of his own statements in the assent of his pupils. This is, to say the least, unusual; but we cannot at once either commend, or find fault with, it. It is a new departure, and its value and usefulness must be judged by its success.

There are a few elementary, but important, points in Dynamics, by his treatment of which every author on the subject shows at once whether he is "sound in the faith" or not. On the whole, Prof. Lodge passes these tests with credit; and the rest of his book is of a much higher order than the run of elementary treatises.

There are, however, here and there some singular slips, which should be corrected in future editions. We note only one or two, but even these are destructive of the character for definiteness and accuracy which should be the leading feature of every scientific book. Thus, in §5 (where, unfortunately, a "statical" definition of force is introduced as well as a "kinetic" one) we are told that *change of motion* "is called" *Acceleration;* though in later sections the true meaning:—i.e. *Rate of* Change of *Velocity*:—is assigned to Acceleration. To the mere popular reader this may appear hypercriticism; but science is most careful to distinguish not only between *Change* and *Rate of Change*, but also between *Motion* and *Velocity*. Again, in § 16, serious confusion is introduced by the statement that the velocity of a point at unit distance from an axis "*is called*" the angular velocity of the rotating body. Prof. Lodge knows perfectly well that it is not so, and that none but unscientific people could confound a quantity of dimensions $[T^{-1}]$ with another of dimensions $[LT^{-1}]$; even when, as in the present case, their *numerical* values happen to be equal. We are tempted to seek an explanation of, and thus to find an excuse for, these and other similar slips, in his inexcusable partiality for the works of Deschanel and Ganot.

P. G. T.

The Ocean, &c. By W. L. Jordan. Second Edition. (London: Longmans, 1885.)

OF this elaborate work it is enough to say that it is based on "*The* New Principles of Natural Philosophy." These principles we sketched (June 21, 1883) in an article which, as his mode of acknowledgment showed, was by no means satisfactory to our Author. That *Vis Inertiæ* was entirely misunderstood by Newton, and that *unresisted* motion ultimately comes to rest, are among the chief foundations of this work! That a terrestrial globe whose frame is carried round through a portion of a curve, and then suddenly stopped, will rotate in consequence, is conceivable: but we should try to explain the fact by bad centering, or some such cause; certainly not by the assumption that, during the curvilinear motion, one part of the equator had necessarily a greater *linear* velocity than the opposite part. Our Author does not seem to be acquainted with the most elementary properties of the kind of motion called Translation! But this is merely, on his part, the most recent revival of Jelinger Symonsism:—for it assumes the fundamental tenet of that peculiar heresy; viz. that a body, which revolves round a centre, is not rotating if it turn always the same side to the centre. It is needless to say more on this melancholy waste of time, trouble, and ready money (the latter especially): on the part of an author who has been complimented by a reviewer of one of his other works as having "a familiar acquaintance with questions of finance." See *Advertisement* appended to the present volume.

P. G. T.

Spectrum Analysis. By Dr. H. Schellen. Translated from the Third German Edition by Jane and Caroline Lassell. Edited, with Notes, by Capt. Abney, R.E., F.R.S. (London: Longmans, 1885.)

THIS is the second edition of a well known book: in its general arrangement there is little departure from the first, which appeared in 1872. While the German edition from which it has been translated was being prepared, the author unfortunately died; it is not to be wondered at therefore that the present reprint does not reflect the present state of our knowledge so accurately as did the former one; indeed there is evidence that the German editor has been compelled by the sad circumstances under which this task devolved upon him to take what was readiest to his hand.

Some of the material however is very valuable: thus, for instance, we have a complete and well illustrated account of Vogel and Huggins' work on the spectra of stars, much interesting information concerning Prof. Rowland's new concave gratings; while the English editor has added a full account of Abney, Festing, and Langley's work on infra-red spectra, and Abney and Schuster's discussion on the photographs taken during the eclipse of 1882. With these exceptions the English, French, or Italian work accomplished during the last ten years is but imperfectly referred to. The names of Thollon and Tacchini, to say nothing of Crookes and Hartley, not even being in the index. To the student therefore the book is worse than useless, it is misleading. The popular reader, however, who does not care too much for completeness will find much information conveyed in a pleasant form. The main branches of the science, both in its terrestrial and celestial applications, are dealt with, and the methods of work are given. Great interest also attaches to the various forms of instruments used in the new science; many of these are described, from a new form of pocket spectroscope—which we learn from the index was devised by Capt. Abney—to the more complex apparatus designed by Vogel, von Konkoly, and others.

The theoretical parts are perhaps most to be avoided. The chapter on the plurality of spectra, for instance, will help the reader very little in coming to a conclusion upon a subject of fundamental importance. Such a statement, too, as that on p. 268, "That Kirchhoff's theory has received full confirmation from the observations of solar total eclipses" is not so true as the writer evidently thought it to be.

Again, on the question of the change of refrangibility of light due to the motion of a light source towards or from the eye. The complete statement made by Fizeau in 1848 appears to be unknown to the author, who attributes the solution of the problem to Mach, of Prague, in the year 1860.

The translators have done their work throughout in a very admirable manner, showing that they possess a perfect acquaintance with the subject.

There are, however, a few minor blunders; thus, for instance, the substitution of the word "length" for "longitude" in connection with the perihelion and node, plays havoc with the elements of a comet's orbit, given on p. 584, while the diagram on p. 387, illustrating the change of wave-length, is rendered unintelligible by the misplacement of the figures indicating miles per second.

A Practical Arithmetic on an entirely New Method. By John Jackson. (London: Blackie, 1885.)
Principles of Arithmetic. By Homersham Cox, M.A. (Cambridge: Deighton, 1885.)

As the title-pages indicate, these attack the subject from quite different sides: the former is eminently practical, and everything unpractical is carefully eschewed: the latter goes into the principles and considers all from the theoretic side, giving very little practice.

Mr. Jackson aims at giving the easiest and shortest rules he can; explanations are few, the deficiency to be met by black-board illustration. The fractional form for the solution of questions is adopted in the advanced rules; but the most noticeable feature is the exclusion of the rule of "subtraction" and the substitution of what the writer calls "incremental or complementary addition." To take an example in compound complementary addition:—A pays a bill of 15*s.* 8¾*d.* with a sovereign; the tradesman says, "15*s.* 8¾*d.* with a farthing (puts it down) make 15*s.* 9*d.*, and 3*d.* (puts it down) make 16*s.*, and 4*s.* (puts it down) make one pound." There is no new difficulty introduced here, and a beginner is taught a good practical lesson. There is a vast collection of examples, numerous examination papers, and a good store of sums worked out on the usual plan, as well as on that put forward by the writer. There are 25 pages of tables containing specific gravities, a mariner's compass, a perpetual calendar (to A.D. 1925), compound interest results, square and cube numbers, prime numbers and logarithms. Some space, as might be expected, is devoted to "mental arithmetic." We have shown, we think, that this book well merits its title of a "practical" arithmetic.

Mr. Cox at once states "the object is to give an account of the principles of arithmetic, omitting all merely mercantile applications." The author takes as his guide, in the main, Cantor's "Geschichte der Mathematik," consulting also Hankel and Nesselmann ("Algebra der Griechen"); but "the conception of the subject as a whole, and many of the details, have been taken from the mathematical portions of the works of Auguste Comte, and in especial from his last great work, the 'Synthèse subjective.'"

There is no index nor table of contents, which is a drawback to the ready use of the book. There is an introduction, and then come seven chapters. Chapter I. discusses Numeration; Chapter II. is devoted to the first four rules in four sections; Chapter III., on Properties of Numbers, is divided into four sections: (1) Theorems (the commutative, the associative, and distributive); (2) G.C.M.; (3) Prime and Composite Numbers; (4) L.C.M. Chapter IV., in four sections, treats of the four rules for fractions, and in the fifth section discusses Ratio and Proportion. Chapter V., in six sections, treats of Decimal fractions. Chapter VI., in four sections, discusses powers and roots, with geometrical illustrations and resumes (in Section IV.) the subject of Ratio and Proportion (applied to incommensurable quantities). Chapter VII., in three sections, resumes the discussion of Properties of Numbers, as regards Permutations, the Arithmetical and Geometrical Progressions, and Figurate Numbers. There are a few exercises appended to the sections. The book in parts reminds us much of De Morgan's Arithmetic: it will be valuable for teachers, even if they have read the works cited in Mr. Cox's preface. It is by no means a school-book, though senior boys may derive much interest as well as profit from its perusal.

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. No notice is taken of anonymous communications.*
[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Recent Total Eclipse of the Sun

By last mail I sent you a brief account of my eclipse observations at Tahoraite on the 9th inst., and a diagram illustrating the corona. Owing to a miscalculation as to closing time of mail the account had to be very hurriedly written; there was no time to revise it or to find out the longitude and latitude of the point of observation, but this information I am now able to supply from the Trigonometrical Survey Records at Napier:—

	Longitude		Latitude
Centre of railway station at Tahoraite, Hawkesbay	176° 5′ 7″·07	...	40° 13′ 17″·22

The longitude and latitude of the nearest Trigonometrical Station, No. 83, from which the above were calculated, seems to have been originally fixed with reference to Trigonometrical Station No. 60, Lighthouse Reserve, Napier, whose latitude then, according to observations taken in January 1871, was 39° 28′ 47″·30. According to fresh observations taken in February 1885 the latitude of the same point is 39° 28′ 43″·52 ± 0° 0′ 0″·04. If both series of observations are correct, a *reduction* in latitude to the extent of about 3″·78 must have taken place since 1871.

Considering the position of New Zealand at the Antipodes of Europe, where a reduction of latitude seems to have occurred, a reduction like the one above indicated, bearing as it does on a very interesting question, has particular importance and urgently calls for confirmation. As mentioned in my last letter, the corona reminded me of an auroral display. The rays all seemed radially disposed and perfectly straight with well defined edges. The differences in length were very remarkable. All the observers I have spoken to agree as to the position of the longest ray, but not as to that of the others. The public attention was, however, fixed on the red protuberances and the other phenomena of the eclipse, and little notice was evidently taken of the corona.

N. A. Graydon

Hastings, Hawkesbay, New Zealand, September 25

Ophthalmologic Education in the United Kingdom

I did not see your notice of my translation of Fuchs's "Causes and Prevention of Blindness" until to-day. I find two accusations brought against me, which I do not admit to be well founded.

(1) I am accused of "mistranslation" because I have often rendered "Augenheilkunde" by the word "ophthalmology." You state that "the treatment of diseases of the eyes' would be the correct translation. "Ophthalmic medicine," which is my alternative translation, is more correct than the translation you offer; but ophthalmology is quite sufficiently correct, and in many cases is employed by the author indifferently with "Augenheilkunde," to express the same thing. No doubt "ophthalmology," etymologically considered, is a more comprehensive word than "Augenheilkunde" or its English synonym "ophthalmic medicine;" but custom has sanctioned its employment in the limited sense of the latter word in Germany, in France, and in this country. Thus the Professor of Ophthalmic Medicine in Vienna was Professor of Ophthalmology. Fuchs constantly speaks of "ophthalmological clinics," and in many of the medical schools of this country the lecturers on what is in other schools called "ophthalmic surgery," "diseases of the eye," &c., are called lecturers on "ophthalmology" (King's College, Yorkshire College, Liverpool University College, Owens College, Catholic University School of Medicine, Dublin).

(2) I am blamed for not correcting Fuchs when he says, "As a rule no regular lectures on ophthalmology (Augenheilkunde)

are delivered in the medical schools of Great Britain and Ireland." You say: "Systematic lectures are delivered in every medical school in the United Kingdom; and it is difficult to believe that the translator could have been unacquainted with the fact." Now, I do not admit that it is the duty of a mere translator to correct all the errors of the original, and, as a matter of fact, I have, I think, only once put the author right (at p. 109); but I do not admit the author to be wrong in his assertion. Looking through the *Medical Directory* for this year, I find that eleven medical schools make no provision whatever for ophthalmological instruction, and I doubt very much if the "Ophthalmic Demonstrations," "Clinical Lectures on Diseases of the Eye," "Ophthalmic Surgery," &c., advertised at many of the other schools, would properly come under the head of Dr. Fuchs's "regular lectures," or the "systematic lectures" you speak of. As it is upwards of forty years since I was a student at a medical school, I may of course be mistaken respecting the present state of ophthalmologic education in this country; at all events, I had not any knowledge of an opposite state of things which would have enabled me to say that Dr. Fuchs was wrong in saying that "*as a rule* no regular lectures on ophthalmology are delivered" in our medical schools, and the facts I have given above seem to prove that "regular lectures" on ophthalmic medicine are still the exception in the medical schools of the United Kingdom.

R. E. DUDGEON

53, Montagu Square, November 4

[We have referred Dr. Dudgeon's letter to the writer, who replies as follows:—

Dr. Dudgeon's letter will not bear a moment's examination.

In the first place he misstates what he calls the "first accusation." He was not accused of "often" rendering "Augenheilkunde" by "Ophthalmology," but of having done so in one particular place, in which the effect of the mistranslation was to give a certain amount of colour to a statement which, in the original, was wholly untrue.

It is obvious that "Ophthalmology" is neither English, French, nor German. It is common to all three, and the forms of it differ only in termination. "Ophthalmologie" should be rendered by "ophthalmology," and *vice versâ*. Its meaning embraces everything appertaining to the eyes, and its German equivalent is "Augenlehre."

"Augenheilkunde," on the other hand, is a word of limited significance, the meaning of which embraces only the treatment of affections of the eyes. Dr. Dudgeon's suggested rendering, "Ophthalmic Medicine," is so far inadequate that it might not be understood to include surgery, and it could hardly be understood to include the use of optical appliances. "Augenheilkunde" forms part of ophthalmology, an important part indeed, but a part only.

Dr. Fuchs asserted that, "as a rule, no regular lectures on 'Augenheilkunde' were delivered in the medical schools of Great Britain and Ireland." This assertion, very possibly made in honest ignorance, is absolutely the reverse of the truth. Dr. Dudgeon altered it into the statement that "no regular lectures on ophthalmology" were so delivered. This, in a sense, is true; because the lectures, which cover the whole extent of "Augenheilkunde," neither cover, nor attempt to cover, "ophthalmology."

I do not think it is too much to expect that a translator shall correct a misstatement in the original work, especially when that misstatement is one which casts a wholly unmerited stigma upon the institutions of the translator's native country. Instead of correcting it, Dr. Dudgeon casts it into an altered form, in which it may be said to be true literally, although calculated to produce an entirely erroneous impression upon the reader.

Dr. Dudgeon must not go to the extremely condensed statements of the *Medical Directory* for complete accounts of the work done by British Schools of Medicine, but to the prospectuses of the schools themselves. There are thirteen such schools in London, and regular lectures on "Augenheilkunde" are delivered at all of them; at Bartholomew's by Messrs. Power and Vernon; at Guy's by Mr. Higgins and Dr. Brailey; at King's College by Mr. MacHardy; at the London by Mr. Waren Tay; at the Middlesex by Mr Lang; at St. George's by Mr. Brudenell Carter and Mr. Frost; at St. Mary's by Mr. Critchett; at St. Thomas's by Mr. Nettleship; at University College by Mr. Tweedy; at the Westminster by Mr. Cowell; at the West London by Mr. Vernon; at the School of Medicine for Women by Mr. Mackinlay. At Charing Cross the lectures are delivered by arrangement with the staff of the adjacent Westminster Ophthalmic Hospital. It would be tedious to enter into particulars with regard to the provincial, Scotch, and Irish schools, but similar lectures are delivered in all of them.]

The Helm Wind

THE *helm wind* of Cumberland has been the subject of much discussion in England. I wonder how the true explanation has not been found, viz. *that the helm wind is a bora, i.e.* identical in character with the extremely strong dry east and north-east winds blowing on the coasts of Istria and Dalmatia, as well as on the north part of the east coast of the Black Sea, especially at Novorossiisk. At the latter place it blows from the Varada chain, about 2000 feet high, and, as with the helm wind, it is not felt a little distance to the east. I give the translation of a passage on the bora in my book on "The Climates of the World":—

"Seamen call the bora an *air-waterfall*. There is reason to believe that it begins when the stable equilibrium between the air-strata on the mountain and the bay is disturbed, *i.e.* when the latter is more than 10° warmer than the former. The Varada chain falls in a gentle slope eastward towards the broad Adegoa valley, to the north-east of which is the Svinzovy (Lead) chain. In this walled-in valley the temperature is much lower than on the coast, especially in winter and autumn, and when the cold air fills it to overflowing there arises an unstable equilibrium towards the west, and the colder it is on the mountain in comparison to the bay, the stronger is the reaction, *i.e.* the bora."

Here also the bora may arise, not only on account of a strong local cooling of the air in the Adegoa valley, but also accompany general north-east winds to the north of the Caucasian chain. They bring cold air from afar, are sometimes prevented by the Varada chain from sinking to the sea-level, and during this time the equilibrium is disturbed and they appear as bora, even if they blow as gentle farther to the east.

I have no doubt the English helm wind is also due to a disturbed equilibrium. The east is colder than the west, and the contrast is stronger when east winds blow, *i.e.* local radiation makes the east yet colder, and in short a difference of temperature of about 14° is likely to occur between the Cross Fell Range and the Penrith valley. In summer the wind is not felt—the west being then colder than the east; and it is less frequent in winter than in November, March, and April, because the prevailing west winds and the cloudy weather which necessarily accompanies them equalise the temperature.

St. Petersburg, October 19 [31] A. WOEIKOF

The Resting Position of Oysters

THE evidence adduced by Mr. Cunningham to prove that oysters rest on the right or flat valve in their natural state seems conclusive. Remembering, however, that I possessed a young oyster-shell detached from a sandstone rock years ago on the coast of Arran, I turned to it, and was surprised to find that the lower or attached valve was unmistakably the larger, overlapping the other at the hinge and all round. I have another single valve of some foreign species taken from a Haliotis shell, which furnishes similar evidence. Apparently, therefore, in the young or attached state it is the larger or convex valve which is the lower, and probably this is the evidence on which the ordinary statement in conchological books rests. It will be curious if the truth turns out to be that the oyster changes its position when it becomes unattached. Perhaps the remarkable inequalities in the shape of the convex valves may arise from the inequalities in the objects to which they are originally fixed.

W. TURNER

27, Queen's Crescent, Edinburgh

The Australian Lyre Bird

HAVING been stationed at intervals for some years on the mountains of Eastern Manaro, in the southern part of New South Wales, the habitat of the Lyre Bird or Native Pheasant (*Menura superba* or *Paradisea*), I have thought some fuller particulars regarding its habits, than are usually obtainable, might be interesting to your readers.

This range of mountains, the more sheltered sides of which form the home of these interesting birds, attains a height of over 4000 feet above sea level. The sides, sloping towards the coast at a general angle of about 45°, are heavily timbered with eucalypti, wattle, and musk trees, and covered with a dense undergrowth of ferns and creepers, the gullies being filled with tree ferns. Generally speaking there is a noticeable absence of game, but at certain seasons the forest resounds with the varied cries of the male lyre bird. The hen builds her nest at the foot of a trunk of a tree, of twigs and bark, lining it with dried ferns and grass, and leaving an opening in the front of the top. Herein she deposits the *one* egg on which she sits to incubation (for, as an Irish friend said, "she only lays one egg at a time"), leaving the nest daily for food. The country abounds in the hills of ants, from those of the large bull-dog ant, an inch long, to those of a small black variety, and it is upon these insects and their larvæ that the lyre bird chiefly subsists. The bird is of a sooty black colour, with a body somewhat larger than that of a pigeon, but has a tail of graceful form and beautifully marked. Ordinarily, this tail is simply carried behind like a peacock's in repose, but if found upon their "dancing beds" with head erect and tail expanded over the back they are decidedly handsome. These "dancing beds" are patches of comparatively clear ground, from one to two yards in diameter, with the ferns trodden smoothly upon the surface, upon which the birds assemble, and dance and strut to their apparent great delight. The original cry or call of the lyre bird is a very simple one, but his adopted one partakes of that of every sound he hears; for he is a most wonderful mocker, not only of other birds, such as the parrot, cockatoo, yang yang, or magpie, but he will imitate, to the life, the bullock driver with his whip, the step of the teamster's horses, the rasping of the cross-cut saw, and the blows of the axe and tomahawk, and more wonderful still, more than one of these at the same time, so that the solitary explorer is led to believe he has suddenly come upon pioneers of civilisation in the heart of the forest.

The male bird is exceedingly pugnacious, and this fact is made use of by the settlers to his destruction, for his tail is worth $3. By imitating one of his prominent calls, the hunter can lure him within gun-shot, although naturally very shy; he comes to repel a fancied intruder into his domain. His flesh is very dark-coloured and coarse, and only used as food in cases of necessity. Many attempts have been made to rear the birds in captivity, and there is a report that *one* has been successful. With this exception, which I cannot authenticate, I never heard of any result but failure.

The sound of his call so alters in proportion as his tail is in full feather or indifferently ornamented, that hunters can judge from that whether or no any individual bird is worth pursuit.

My apology for asking for so much of your valuable space must be in the fact that until I set myself the task of getting the above information, I could not obtain it from published accounts.

ALFRED MORRIS

Railway Survey Camp, Manaro, New South Wales, September 1

Blackberry Blossoms in November

I HAVE this day seen blackberry blossoms in a hedge on this road, and yet the autumn has been rainy and inclement.

JOSEPH JOHN MURPHY

Osborne Park, Belfast, November 10

EXPLORATIONS IN PAHANG

PAHANG is a small state in the Malay peninsula on the eastern side of the dividing range, with a coast-line on the China Sea. The territory is almost exclusively occupied by Malays, who live on the banks of the rivers; but in the unexplored forests of the interior near the mountains there are a few tribes of wild aboriginal Sakeis. Though Pekan, the capital, is not quite 200 miles from Singapore, it is rarely visited by Europeans. It is situated at the mouth of the river Pahang, and on this stream the bulk of the population is to be found. The Pahang is the main artery of communication with the interior. Its course is inaccurately laid down on the map published by the Straits Government in 1879. Quite recently, however, Mr. W. Cameron, a surveyor, has by his own efforts, unassisted by the Government, mapped the whole course of the stream, and his map, not yet published, is in the hands of the Straits branch of the Royal Asiatic Society. Recently also the river was ascended by Mr. G. Scaife. He went up by the Semanten River and one of its tributaries to the dividing range, and then, accompanied by Malays only, he crossed to Klang, in Selangor, in three days, and so reached the western coast. In May of this year Mr. Swettenham, the Government Resident in Selangor, succeeded in passing the dividing range from Perak by ascending the River Slim. Having descended on the eastern side of the mountains he reached the Lipis River, down which he came on rafts to the Pahang, and so on to Pekan. The whole journey occupied one month.

It may seem strange that a territory so near Singapore should be so little known. The reasons for this are that on the land side its jungles and forests are very inaccessible, and that for six months of the year, when the north-east monsoon is blowing, the rivers and coast-line can scarcely be approached from the sea. Pahang has always had a peculiar interest because of the large and rich gold mines said to exist within its limits. Curious specimens of nuggets are constantly reaching the British settlements from this locality.

In July last I started from Singapore with the intention of seeing some of the gold fields and generally to examine the geology of the river and some of its tributaries. I was accompanied by Mr. H. G. James and Mr. Scaife. A small steam launch had been sent on previously, and we hoped by its means to save time and the inconvenience of depending on native boatmen.

Pekan, the capital, lies about six miles above the mouth of the river. It is a small town of perhaps 1500 inhabitants. It is well laid out in rectangular grassy streets. The sides of these are formed of high bertane fences, within which, buried in tropical foliage, are the detached bungalows of the inhabitants; the houses are built high off the ground with attop roofs. There is one street of wretched Chinese shops called the market. In the midst of this is a somewhat pretentious two-story palace for the Sultan. Close by are many sheds built for games for royal diversion, amid which is a conspicuous inclosure covered in, where for many hours almost daily his Highness plays at top-spinning with his nobility and gentry.

He received us courteously at midnight (a common hour for receptions) and seemed quite pleased to have his country visited by Europeans. He gave us a letter commanding all chiefs (Datus) to give us any help we might require. He does not affect any royal splendour, but is very simple in his habits. He is a liberal-minded man, who might do much but for his indolence.

We started with a party of thirteen in a large river prahm, in case the launch should fail us, which it promptly did. Though only drawing 2 feet 8 inches we lost four days in advancing fifteen miles. At last the shallows stopped us altogether, and we had to take to the prahm. The Pahang drains an immense basin and is fed by innumerable tributaries, so that it is rather disappointing to find that unless in times of flood it is only navigable for the small prahm of the Malay. The largest of these scarcely draws two feet of water.

The channel is from 300 to 600 yards wide, interrupted continually by jungle islands and large sandbanks. On the latter pea-fowl (*Pavo javanicus*) are commonly seen. The banks are lined at intervals with small villages. They may be known at a distance by the clumps of cocoa-nut and betel palm. On our approach we frequently heard the wooden gong or drum echoing with singular clearness through the forest. It reminded one of what Stanley tells us of the River Congo, except that the Pahang natives are very peaceable. The vegetation was of the usual Malay character. The common trees were Ficus, Phyllanthus, Vitex, Castanopsis, Garcinia, Dipterocarpus, Fagræa, Hibiscus, &c., with creepers and vines innumerable, especially Bauhinia, Vitis, Ipomæa, Entada, and Mucuna. I saw very little that was new to me, but there was no time for any search. At forty miles we came to the River Lint, which at one time had a great reputation for its gold mines. Two Europeans have started to prospect the locality. We met with them on our return. They had found traces of very extensive workings in former times, but the whole are quite abandoned. The country around is hilly, and the banks of the river are beautifully picturesque. Scarcely any natives live in the vicinity.

We passed many small tributaries to the right and left, and at ninety-one miles, or eight days, from Pekan passed the Semanten, a large affluent coming from the west. Our course had been west hitherto, but now turned to the north-west. Our progress was but slow. We had hired a second boat, and both had to be urged against a strong current by means of long poles—the usual mode of up-stream progress in the Malaysia. One seldom averages more than a mile an hour in this way.

At about 130 miles we passed the Tomoleng, a large stream to the right. It was up this, I believe, that Baron Maclay passed in 1875. The river to the left is called the Jelis or Jelai. Between the two there is a very small stream which is called the Pahang. In Cameron's map the Jelai is marked as the Pahang, but the natives do not call it so. The Jelis is still a fine river, with fewer sandbanks, and I think a deeper bed. Fifty miles further we reached the Lipis. Where we left the Jelis it was still an important stream at least 200 yards wide. The Lipis is also a good stream, half the width of the former. We only went about ten miles up it, and at that distance or less came to Punjom, a large village, the second in importance to Pekan. We found that the cholera had just visited the place, and carried off half the inhabitants, and we found subsequently that several other villages had been visited, or were actually suffering from this terrible epidemic.

About three miles from Punjom is a celebrated gold mine at a village called Jelai, which has been worked for centuries. The formation is just like what is seen in the auriferous districts of Australia—that is to say, highly inclined slate schists and sandstones with quartz lodes containing the gold. The mines, I am told, have been worked in succession by Siamese, Malays, and Chinese. At present about thirty Chinese are employed, with a few Malays, who wash the sands for gold dust. The locality is very curious, from the evident antiquity of the workings. An enormous quantity of material has been quarried away, and shafts have been sunk in the solid rock. Subsequently the rock has been removed, leaving traces of the shafts on the faces of the quarries. It seems as if the miners had found gold in the alluvium, and then had removed the rock in searching for more. The lodes were scarcely touched, probably being too hard. But just beside the lodes the casing with some pockets of pyrites have been taken out in small quantities and are still worked. Doubtless these ores are rich, but a small quantity of free gold dust is all that these miners get.

The ground for acres around is covered with refuse heaps, and after each rainfall the native women and children may be seen searching for specks of gold in the sand. There is a good deal of iron pyrites in the heaps, and as this gradually decomposes, the gold is liberated in the form of fine dust. The mine is about to be worked by a European company.

I returned from Punjom down the Pahang as far as the Semanten, and ascended that river almost due west for about 50 miles. It then forks into the Karau (W.N.W.) and the Brentong (S.W.). As the latter was a series of rapids we changed our boats for small canoes. The water is very deep in places, but shallow at the rapids, where it falls over barriers of beautiful black marble with white veins, or over slate rocks, highly inclined and much jointed. It took us a whole day to ascend about 15 miles, as there was a fresh in the stream. This made the work of poling up the rapids difficult and exciting. After the first few miles we saw no habitations, but we met small bamboo rafts carrying down ingots of tin from the village of Brentong. The river flows in a channel about 50 yards wide, through a dense forest echoing with the cry of the large black siamang or gibbon monkey (*Hylobates syndactylus ?*). Occasionally we heard the peculiar warning shriek, as I may call it, of the wild aboriginal Sakei.

We left our canoes at the junction of a mountain torrent called the Dua. Here we camped one night, and then crossed to the sources of the stream, passing over several high mountain spurs from the main divide. In the mountains we found a few Malays washing stream tin from a shallow, coarse gravel. This consisted of broken Palæozoic slates and sandstones. We visited two or three mines of this kind in various places in the ranges. Travelling was very difficult, because of the undergrowth amid a fine forest of Dipterocarpus, oak, chestnut figs, Dammar, Fagræa, &c., with much Bertam palm (Huguessonia). Traces of tigers and elephants numerous. Game plentiful. In the river a very large barbel and a smaller one abundant (*Barbus burmanicus* and *Kolus ?*), both tasteless fishes and full of bones. We found also an eel-like voracious fish, which I took to be *Ophiocephalus micropeltes*, excellent eating, but uncommon. I have found the same fishes in all the mountain rivers of the Malay peninsula.

We returned direct to Pekau from the Sungei Dua, having spent about five weeks in the boats. Throughout we found the people affable and courteous, not timid of strangers, though some of them had never previously seen white men. Their only medium of exchange is a tin coinage, shaped for the most part like an old-fashioned square inkstand. They objected to receive the smaller silver coin of the Straits Settlements, but would take an empty bottle or a meat or biscuit tin in exchange for a fowl, and fruit such as bananas, cocoa-nuts, mangostems, and papaws, besides tapioca, maize, and brinjals.

We saw a few slaves, who seemed to be Sakeis or Africans. The whole population of the State can scarcely be 50,000, of which probably not 500 are Chinese.

About half way between the dividing range and the sea there is a belt of detached conical steep mountains 1500 to 2000 feet high. From the specimens of rock abutting on the River Pahang I judge these hills to be volcanic, and to consist of trachytic and felspathic rocks. I also found in the bed of the stream isolated patches of andesite, felsite, molaphyre, and limestone. In respect to the volcanic rocks the eastern side of the Malay peninsula differs much from the western. J. E. TENISON-WOOD

Singapore, August 28

P.S.—I have just seen in a number of NATURE, published in the early part of this year, a letter from Mr. L. Wray, jun., correcting what he considers certain mistakes of mine. It is due to your readers to state that I do not accept any of these corrections. During the long period that I have spent in exploring in these regions, Mr. Wray travelled with me for about a fortnight. I should like to repeat that I have never seen on the Malay peninsula any sign of upheaval or subsidence. The instance Mr. Wray refers to at Matang obviously admits of a very different interpretation.

THE CRETACEOUS FLORAS OF CANADA[1]

Geological Relations of the Floras

IN a memoir published in the first volume of the *Transactions* of this Society I have given a table of the Cretaceous formations of the western North-

[1] By Sir William Dawson, F.R.S., &c. From advance sheets of a memoir to appear in the *Transactions* of the Royal Society of Canada.

West Territories of Canada, prepared by Dr. G. M. Dawson, and have fully stated the geological position of the plants at that time described. The new facts detailed now require us to intercalate in our table three distinct plant-horizons not previously recognised in the western territories of Canada. One of these, the Kootanie series, should probably be placed at the base of the table as a representative of the Urgonian or Neocomian, or, at the very least, should be held as not newer than the Shasta group of the United States Geologists, and the Lower Sandstones and Shales of the Queen Charlotte Islands. It would seem to correspond in the character of its fossil plants with the oldest Cretaceous floras recognised in Europe and Asia, and with that of the Komé formation in Greenland, as described by Heer. No similar flora seems yet to have been distinctly recognised in the United States, except, perhaps, that of the beds in Maryland, holding cycads, and which were referred many years ago by Tyson to the Wealden.

The second of these plant-horizons separated, according to Dr. G. M. Dawson, by a considerable thickness of strata, is that which he has called the Mill Creek series, and which corresponds very closely with that of the Dakota group, as described by Lesquereux, and that of the Atané and Patoot formations in Greenland, as described by Heer. This fills a gap, indicated only conjecturally in the table of 1883. Along with the plants from the Dunvegan group of Peace River, described in 1883, it would seem to represent the flora of the Cenomanian and Turonian divisions of the Cretaceous in Europe.

Above this we have also to intercalate a third sub-flora, that of the Belly River series at the base of the Fort Pierre group. This, though separated from the Laramie proper by the marine beds of the Pierre and Fox Hill groups, more than 1700 feet in thickness, introduces the Laramie or Danian flora, which continues to the top of the Cretaceous, and probably into the Eocene, and includes several species still surviving on the American continent, or represented by forms so close that they may be varietal merely.

Lastly, the subdivision of the Laramie group, in the last Report of Dr. G. M. Dawson, into the three members known respectively as the Lower or St. Mary River series, the Middle or Willow Creek series, and the Upper or Porcupine Hill series, in connection with the fact that the fossil plants occur chiefly in the lower and upper members, enables us now to divide the Laramie flora proper into two sub-floras—an older, closely allied to that of the Belly River series below; and a newer, identical with that of Souris River, described as Laramie in Dr. G. M. Dawson's Report on the 49th Parallel, 1876, and in the Report of the Geological Survey of Canada for 1879, and which appears to agree with that known in the United States as the Fort Union group, and in part at least with the so-called Miocene of Heer from Greenland.

From the animal fossils and the character of the flora it would seem probable that the rich flora of the Cretaceous coal-fields of Vancouver Island is nearly synchronous with that of the coal-bearing Belly River series of the western plains.

It will thus be seen that the explorations already made in Canadian territory have revealed a very complete series of Cretaceous plants, admitting, no doubt, of large additions to the number of species by future discoveries, and also of the establishment of connecting links between the different members, but giving a satisfactory basis for the knowledge of the succession of plants and for the determination of the ages of formations by their vegetable fossils.

The successive series may be tabulated as follows, with references for details to the fuller table in my memoir of 1883:—

Successive Floras and Sub-Floras of the Cretaceous in Canada (in Descending Order)

Periods	Floras and Sub-Floras	References
Transition Eocene to Cretaceous	Upper Laramie or Porcupine Hill Series ...	Platanus beds of Souris River and Calgary. Report Geol. Survey of Canada for 1879, and memoir of 1885.
Upper Cretaceous (Danian and Senonian)	Middle Laramie or Willow Creek Series.	
	Lower Laramie or St. Mary River Series ...	Lemna and Pistia beds of bad lands of 49th Parallel, Red Deer River, &c., with Lignites. Report 49th Parallel and memoir of 1885.
	Fox Hill Series	Marine.
	Fort Pierre Series	Marine.
	Belly River Series. (See note.)	Sequoia and Brasenia beds of S. Saskatchewan, Belly River, &c., with Lignites. Memoir of 1885.
	Coal Measures of Nanaimo, B.C., probably here ...	Memoir of 1883. Many Dicotyledons, Palms, &c.
Middle Cretaceous (Turonian and Cenomanian)	Dunvegan Series of Peace River. (See note.) ...	Memoir of 1883. Many Dicotyledons, Cycads, &c.
	Mill Creek Series of Rocky Mountains	Dicotyledonous leaves, similar to Dakota Group of the U.S. Memoir of 1885.
Lower Cretaceous (Neocomian, &c.)	Suskwa River and Queen Charlotte Island Series. Intermediate Series of Rocky Mountains ...	Cycads, Pines, a few Dicotyledons. Report Geol. Survey. Memoir of 1885.
	Kootanie Series of Rocky Mountains	Cycads, Pines, and Ferns. Memoir of 1885.

NOTE.—Though the flora of the Belly River Series very closely resembles that of the Lower Laramie, showing tha similar plants existed throughout the Senonian and Danian periods in North America, yet it is to be anticipated that specific differences will develop themselves in the progress of discovery. In the meantime it scarcely seems possible to distinguish by fossil plants alone the Lower Laramie beds from those of Belly River, and if these are really separated by 1700 feet of marine strata, as is now believed on stratigraphical grounds, the flora must have been remarkably persistent. The Dunvegan series of Peace River probably corresponds in time with the marine Niobrara and Benton groups farther south, and the Mill Creek with the Dakota group

Physical Conditions and Climate indicated by the Cretaceous Floras.—In the Jurassic and earliest Cretaceous periods the prevalence, over the whole of the Northern Hemisphere, and for a long time, of a monotonous assemblage of Gymnospermous and Acrogenous plants, implies an uniform and mild climate and facility for intercommunication in the north. Towards the end of the Jurassic and beginning of the Cretaceous, the land of the Northern Hemisphere was assuming greater dimensions, and the climate probably becoming a little less uniform. Before the close of the Lower Cretaceous period, the dicotyledonous flora seems to have been introduced, under geographical conditions which permitted a warm-temperate climate to extend as far north as Greenland.

In the Cenomanian we find the Northern Hemisphere tenanted with dicotyledonous trees closely allied to those of modern times, though still indicating a climate much warmer than that which at present prevails. In this age extensive but gradual submergence of land is indicated by the prevalence of chalk and marine limestones over the surface of both continents; but a circumpolar belt of land seems to have been maintained, protecting the Atlantic and Pacific basins from floating ice, and permitting a temperate flora of great richness to prevail far to the north, and especially along the southern margins and extensions of the circumpolar land. These seem to have been the physical conditions which terminated the existence of the old Mesozoic flora and introduced that of the Middle Cretaceous.

As time advanced, the quantity of land gradually increased, and the extension of new plains along the older ridges of land was coincident with the deposition of the great Laramie series and with the origination of its peculiar flora, which indicates a mild climate and considerable variety of station in mountain, plain, and swamp, as well as in great sheets of shallow and weedy fresh water.

In the Eocene and Miocene periods the continent gradually assumed its present form, and the vegetation became still more modern in aspect. In that period of the Eocene, however, in which the great nummulitic limestones were deposited, a submergence of land occurred on the eastern continent which must have assimilated its physical conditions to those of the Middle Cretaceous. This great change, affecting materially the flora of Europe, was not equally great in America, which also by the north and south extension of its mountain chains permitted movements of migration not possible in the Old World. From the Eocene downwards, the remains of land animals and plants are found only in lake basins occupying the existing depressions of the land, though more extensive than those now remaining. It must also be borne in mind that the great foldings and fractures of the crust of the earth which occurred at the close of the Eocene, and to which the final elevation of such ranges as the Alps and the Rocky Mountains belongs, permanently modified and moulded the forms of the continents.

These statements raise, however, questions as to the precise equivalence in time of similar floras found in different latitudes. However equable the climate, there must have been some appreciable difference in proceeding from north to south. If, therefore, as seems in every way probable, the new species of plants originated on the Arctic land and spread themselves southward, this latter process would occur most naturally in times of gradual refrigeration or of the access of a more extreme climate, that is, in times of the elevation of land in the temperate latitudes, or conversely, of local depression of land in the Arctic, leading to invasions of northern ice. Hence the times of the prevalence of particular types of plants in the far north would precede those of their extension to the south, and a flora found fossil in Greenland might be supposed to be somewhat older than a similar flora when found farther south. It would seem, however, that the time required for the extension of a new flora to its extreme geographical limit, is so small in comparison with the duration of an entire geological period, that practically, this difference is of little moment, or at least does not amount to antedating the Arctic flora of a particular type by a whole period, but only by a fraction of such period.

It does not appear that during the whole of the Cretaceous and Eocene periods there is any evidence of such refrigeration as seriously to interfere with the flora, but perhaps the times of most considerable warmth are those of the Dunvegan group in the Middle Cretaceous and those of the later Laramie and oldest Eocene.

It would appear that no cause for the mild temperature of the Cretaceous needs to be invoked other than those mutations of land and water which the geological deposits themselves indicate. A condition, for example, of the Atlantic basin in which the high land of Greenland should be reduced in elevation and at the same time the northern inlets of the Atlantic closed against the invasion of Arctic ice, would at once restore climatic conditions allowing of the growth of a temperate flora in Greenland. As Dr. Brown has shown ("Florula Discoana"), and as I have elsewhere argued, the absence of light in the Arctic winter is no disadvantage, since, during the winter, the growth of deciduous trees is in any case suspended, while the constant continuance of light in the summer is, on the contrary, a very great stimulus and advantage.

It is a remarkable phenomenon in the history of genera of plants in the later Mesozoic and Tertiary, that the older genera appear at once in a great number of specific types, which become reduced as well as limited in range down to the modern. This is no doubt connected with the greater differentiation of local conditions in the modern; but it indicates also a law of rapid multiplication of species in the early life of genera. The distribution of the species of *Salisburia*, *Sequoia*, *Platanus*, *Sassafras*, *Liriodendron*, *Magnolia*, and many other genera, affords remarkable proofs of this.

Gray, Saporta, Heer, Newberry, Lesquereux, and Starkie Gardner, have all ably discussed these points; but the continual increase of our knowledge of the several floras, and the removal of error as to the dates of their appearance must greatly conduce to clearer and more definite ideas. In particular, the prevailing opinion that the Miocene was a period of the greatest extension of warmth and of a temperate flora into the Arctic, must be abandoned in favour of the later Cretaceous and Eocene; and if I mistake not, this will be found to accord better with the evidence of general geology and of animal fossils.

NOTE.—While this memoir was passing through the press, the Report of Mr. Whiteaves, F.G.S., Palæontologist to the Canadian Survey, on the invertebrate fossils of the Laramie and Cretaceous of the Bow and Belly River districts appeared ("Contributions to Canadian Palæontology," vol. i. part 1, 89 pp. and 11 plates). This valuable Report constitutes an independent testimony, based on animal fossils, to the age of the beds in question, and accords in the main very closely with the conclusions above derived from fossil plants. Unfortunately, however, no animal remains have yet been found in the Kootanie series, and the only fossil recorded from the Mill Creek beds is a species of *Inoceramus* characteristic in the United States of the Niobrara and Benton groups, a position a little higher than that deduced from the plants.

RADIANT LIGHT AND HEAT[1]

IV.

Radiation and Absorption—Celestial Applications.

THE continuous emission of light and heat from the sun and stars through long periods, consisting of millions of years, cannot fail to strike us with amazement, more especially if we regard the great intensity of this radiation. It has been conjectured that the amount of solar heat received by the earth in one year would liquefy a layer of ice 100 feet thick, covering the whole surface of the earth. Now if we bear in mind that the solar heat reaching the earth at any time is only $\frac{1}{2300000000}$ of that which leaves the sun, we may obtain some conception of the enormous radiation from our luminary. It has been calculated by Sir William Thomson that if the sun were a hot solid body, such as carbon, its surface would cool in a few minutes of time. It therefore becomes an object of great scientific interest and importance to discover what is the nature of the peculiar machinery which enables the sun to continue, without interruption, discharging, as it does, into space such enormous quantities of radiant energy. The reply to this question can best be given by a detailed study of the surface of the sun. Whether viewed telescopically or spectroscopically, this

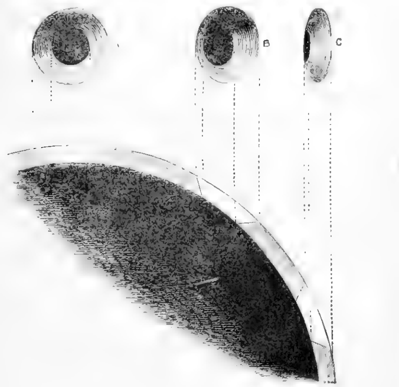


FIG. 11.

surface is by no means that of a globe of uniformly luminous heated matter. Let us begin by examining this surface telescopically.

Shortly after the invention of the telescope Galileo and Scheiner showed that the disc of the sun is far from being uniformly luminous, since it frequently presents the appearance of having large *spots* on its surface. This is a fact which had been previously known to the Chinese. Further research showed that these black spots exhibit at least two degrees of darkness, consisting of a central intensely dark *umbra*, surrounded by a *penumbra*, or semi-dark border. We know now that even the umbra is not absolutely black, but consists of matter at a temperature comparatively low as regards the sun, but comparatively high as regards the earth. It was likewise found in the course of telescopic research that there are patches which are brighter, not darker than the average solar surface or *photosphere*, and these bright patches have been termed *faculæ*.

Thus we have on the solar surface things with three degrees of brightness, consisting of the normal solar surface or photosphere, of the spots which are darker than it, and of the faculæ, which are the brightest of all. The faculæ are more especially to be found in the neighbourhood of spots.

These are the phenomena which may generally be viewed on the sun's surface on any occasion by means of an ordinary telescope. Nevertheless, there are occasions on which we shall find no spots. Schwabe, a German observer, after forty years' patient study of the sun's surface, was successful in detecting a periodicity of these phenomena. There are certain years of maximum and other years of minimum sun-spot frequency, and the average distance from one maximum to the next, or from one minimum to the next, is about eleven years.

FIG. 12.

I have said nothing hitherto about the rotation of the sun, which was discovered by means of the apparent motion of the sun spots over the solar disc. This rotation takes place in about twenty-six days, and its plane is not far removed from the ecliptic, or that in which the earth moves around the sun, the two motions being likewise in the same direction. It has been discovered by Carrington that, as a rule, spots are confined to the regions around the solar equator, never by any chance appearing at the poles.

The nature of these spots has been a subject of much

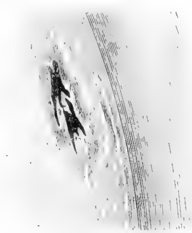


FIG. 13.

discussion. Professor Wilson, of Glasgow, was the first to bring forward evidence indicating that they are below the general level of the solar surface—pits, in fact, the bottoms of which are intensely black, while the sloping sides are less so. This evidence consisted in the fact that when near the sun's border that portion of the penumbra of a spot which is next the visual centre is hidden from our view, a behaviour which is illustrated in Fig. 11. Again, it has been pointed out by the Kew observers that the bottom of a spot is blacker because it is colder than the general surface, and they have likewise brought forward evidence to show that this diminution of temperature has

[1] Continued from vol. xxxii. p. 551.

probably been produced by the downrush of comparatively cold matter from above, a conclusion which has since been abundantly verified by spectroscopic observations.

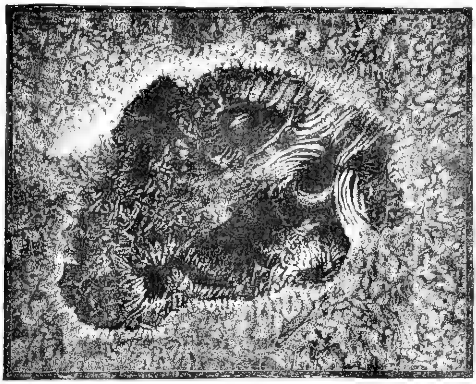


Fig. 11.

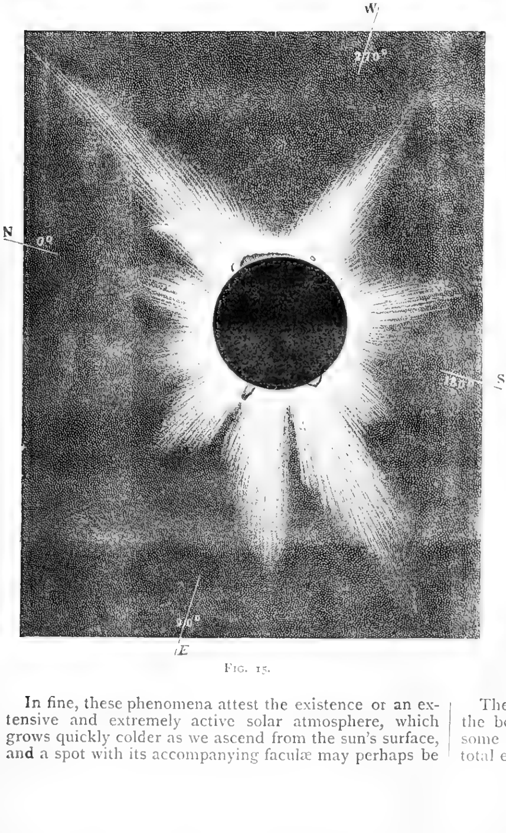


Fig. 15.

In fine, these phenomena attest the existence of an extensive and extremely active solar atmosphere, which grows quickly colder as we ascend from the sun's surface, and a spot with its accompanying faculæ may perhaps be looked upon in the light of a celestial hurricane or hail-storm.

We have in the spot the downrush of a vast quantity of comparatively cold matter from above, and in the faculæ the necessary re-action of this, or the uprush of comparatively hot matter from below, the scale of the operation being occasionally of such a vast magnitude that thirty or forty of our earths might be buried in the pit which represents a spot.

What we have on a large scale in spots and faculæ we have on a small scale all over the sun's disc. When viewed with a powerful telescope the brightness of his disc is found to be far from uniform, the whole surface being made up of bright and dark patches existing side by side. This mottled appearance was first noticed by the elder Herschel, who considered the pores, as he termed them, to be small spots—a conclusion which has since been abundantly verified by the spectroscope. Quite recently M. Janssen, the well-known French observer, has obtained admirable photographs of the sun, exhibiting this mottled appearance on a very large scale. In Fig. 12 we have a picture of a cyclonic sun spot, while in Fig. 13 we have one of faculæ surrounding a spot seen near the sun's edge. Fig. 14 again is a picture by Secchi exhibiting the general mottled appearance round a spot, and the lengthening out of the irregular masses into "straws" in the penumbra.

The phenomena which I have just described are those which are seen projected upon the solar disc. I now go on to describe those which take place near his border. On the occasion of total solar eclipses *red flames*, or *prominences*, are seen to surround the darkened disc of our luminary. At first it was not known whether these belonged to the sun or not, but we are now quite certain that they are true solar appendages. On the same occasions we have, in addition to the red flames, a solar *corona*, or glory, extending sometimes to a very great distance around the solar disc, perhaps even a million of miles or more. Recent observation has proved that this corona is likewise, in part, at least, an undoubted solar appendage.

Having now described the results given us by telescopic observation, let me proceed to those which the spectroscope reveals. Allusion has already been made to the dark lines which occur in the solar spectrum, and which form the characteristic difference betwixt his spectrum and that of the electric light. We have also mentioned the fact that the double solar line D corresponds quite exactly in spectral position with the bright lines given out by incandescent sodium, and that Prof. Stokes conjectured from this coincidence that sodium must exist in the solar atmosphere at a comparatively low temperature.

Professors Bunsen and Kirchhoff in their spectroscopic researches greatly extended this branch of inquiry, showing that many of the dark lines of the solar spectrum are coincident in spectral position with bright lines seen in terrestrial spectra, and concluding that the gaseous substances which afford these spectra must occur in a comparatively cold state in the atmosphere of the sun. The following substances have thus been found to occur in the atmosphere of our luminary—hydrogen, magnesium, calcium, sodium, iron, nickel, manganese, chromium, cobalt, barium, copper, zinc, titanium, aluminium.

The spectroscope has been applied with equal success to the border or limb of our luminary. It was a subject of some surprise that the red flames seen at the time of a total eclipse should be invisible on other occasions; and this perhaps induced observers to imagine that they were not true solar appendages. Independently and nearly simultaneously Janssen and Lockyer showed that these red flames may be rendered visible on ordinary occasions by means of the spectroscope, and they are now the daily study of solar observers. It has been shown that they consist chiefly of incandescent hydrogen, and the reason is very obvious why we cannot see them without the spectroscope. The glare of light around the sun's disc

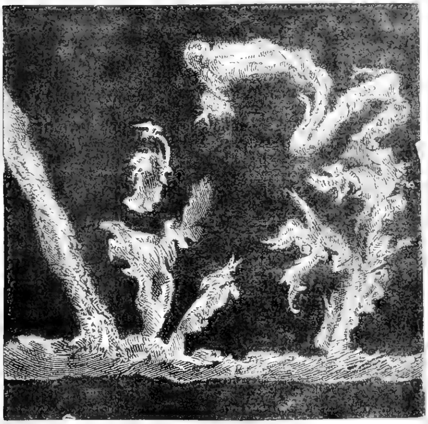


Fig. 16.

(a strictly terrestrial phenomenon due to reflexion) is in general so strong compared to the light from the red flames, that it is impossible for the eye to distinguish the latter. Now during a total eclipse this glare is removed, and hence the eye can see the red flames. But in the spectroscope we have a means not so much of removing as of diluting the glare, while at the same time the light from the red flames is not diluted. This arises from the fact that the glare is ordinary sun-light, consisting of rays of a great many refrangibilities which are spread out into a long ribbon by the spectroscope, and consequently diluted. On the other hand, that from the red flames consists only of one or two widely-separated

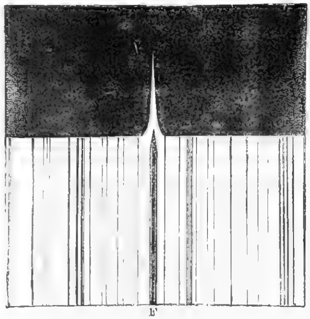


Fig. 17

refrangibilities which are not spread out, and therefore not diluted. The consequence is that the red flames give us a few bright spectral lines standing out in a solar

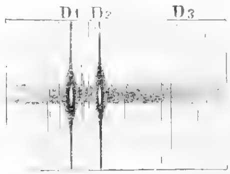


Fig. 18.

spectrum so diluted as to be almost invisible. In Fig. 15 we have a representation of the eclipsed sun showing the red flames near the sun, and the corona extending to a great distance around his disc; while in Fig. 16 we have

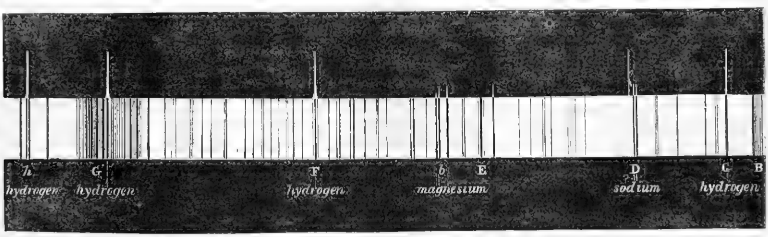


Fig. 19.—Exhibiting the spectrum of the chromosphere above and that of the photosphere below.

an enlarged view of one of the red flames, showing the curious shapes which these phenomena frequently assume.

The application of the spectroscope by Lockyer and others to selected portions of the solar disc and its surroundings has been most fruitful in its consequences.

One of the first results obtained by Lockyer was the arrow-shaped appearance of the bright line F of the sun's atmosphere, when the slit of the spectroscope is made to form a continuation outwards of the solar radius; that is to say, is perpendicular to the rim of the sun.

This is shown in Fig. 17, and the explanation is very simple. It will be remembered that the line F of hydrogen is one which is very susceptible to an increase of pressure. It is therefore much wider at the bottom of the solar atmosphere than at the top, thus presenting the appearance seen in the figure. When the same observer applied the spectroscope to a sun-spot there was found to be a thickening of various absorption lines in the region of the spot, thus indicating an increase of pressure, and proving that a spot is a phenomenon that occurs below the general surface of the photosphere. In Fig. 18 we have the spectrum of a sun-spot as given by Young, exhibiting this thickening in the double line D, a line which, like F, is eminently susceptible to variations of pressure.

It is, however, erroneous to suppose that the solar atmosphere consists entirely of the red prominences already mentioned. These denote merely (as their name indeed implies) the most violently agitated portions of an atmosphere surrounding the whole sun. Lockyer has named this atmosphere the *chromosphere*, and it extends to an average height of about 4000 miles above the surface of the sun. In Fig. 19 we have a picture of the spectrum of the sun's photosphere below and of the chromosphere above.

One prominent constituent of the chromosphere is hydrogen, but we have here a very strange circumstance. Besides certain well-known hydrogen lines, we have in the chromosphere spectrum an orange-yellow line near D, which we cannot identify with the spectrum of any terrestrial substance. It is probably due to some unknown gaseous body which is mixed up with the hydrogen in the atmosphere of our luminary. Again, in the solar corona, we have a green line which we likewise cannot identify; but our opportunities of examining this region are so few and so transient that any conclusion we may come to with respect to its lines must be regarded as provisional.

BALFOUR STEWART

(*To be continued.*)

BULLETIN OF THE UNITED STATES FISH COMMISSION FOR 1884[1]

TO those who are not already familiar with this publication, it is necessary to explain that the bulletin is a journal whose successive numbers appear at short but irregular intervals, each number containing a small collection of brief articles, notes, and reports, on subjects connected with the work of the Commission. At the end of each year the numbers that have been issued during its course are collected into a single volume and republished.

Some of the notes and articles in the volume for 1884 have but a very remote connection with fish or fisheries, broad as is the interpretation given to those terms by the American Commission. In most cases it may be conceded that the information given has some relation to the supply of human food derived from aquatic organisms, or at any rate some bearing on aquatic life. But it is difficult to see the connection between a report on the sanitary condition of the inhabitants of Old Providence Island and the subject of aquiculture. The Report referred to contains many interesting facts concerning the fecundity, education, and diseases of the people mentioned; it would form a valuable contribution to a medical journal, but the fact that its author was surgeon on board the *Albatross* when he acquired the knowledge of his subject is scarcely sufficient to prevent surprise at the appearance of a sanitary report in the Fish Commission Bulletin.

A considerable proportion of the volume is occupied with reprints and translations from journals and publications of other countries, and nearly all of these are interesting and useful. By the republication of these foreign papers the Bulletin becomes a guide to the knowledge of what is being done in aquicultural enterprise in all parts of the world. Among the reprints are several from British journals—for example, the articles which appeared last year in NATURE on the capture of fish larvæ by Utricularia, and an article on the sea-serpent by Richard A. Proctor, which is taken from the *Newcastle Weekly Chronicle*.

Dr. P. Brecchi's Report on the condition of oyster-culture in France in 1881, originally published in the *Journal Officiel*, is given in full; and there are also several other useful articles on the subject of oyster-culture. Mr. John A. Ryder contributes a description with illustrations of a new sand-diaphragm to be used in the cultivation of oysters in marine ponds, and a report on the condition of the oyster fishery at St. Jerome Creek. Lieutenant Francis Winslow reports on some experiments made in 1883 on the rearing of oyster larvæ. The experiments were not completely successful, and the problem of establishing a working system of oyster-culture on the east coast of America still affords scope for the energies of the Fish Commission.

Several articles and reports contain data from which may be ascertained the extent and success of the efforts which are being made to acclimatise various species of fish in waters far distant from their native homes. The introduction of American fish into French streams has been in many cases successfully accomplished by the Société Nationale d'Acclimatisation. Details of the experiments are given in an article compiled from the monthly bulletin of the Society. Pisciculture and the acclimatisation of new species in Germany is treated in several articles by Max. von dem Borne, who is the founder and owner of a large piscicultural establishment at Berneuchen. The bare record of the successful transmission of whitefish eggs to Nelson, New Zealand, and of American black bass to the river Nene in England, is contained in letters which are reprinted.

Reference to any particular article or subject in the volume, in spite of its extremely heterogeneous character, has been made perfectly easy by the number and completeness of the indexes with which it is provided. In the table of contents the names of all the contributors are given in alphabetical order. A topical synopsis follows, in which the various subjects treated in the articles and notes are given under five headings. Finally, at the end of the book, is an accurate and complete general index.

The *Proceedings* of the United States National Museum is published on the same plan as the *Bulletin* of the U.S. Fish Commission. In the "advertisement" to the volume before us (vol. vii. 1884, Washington, 1885) we are told that the series was commenced in 1878 to provide a means for the prompt publication of descriptions of the new and interesting material which was being sent to the Museum by the activity of the collectors employed in its interest. The articles are published in signatures, one of which is issued whenever printed material to the extent of sixteen pages has accumulated. The produce of each year is issued as an annual volume. The articles consist of papers by members of the scientific corps of the Museum, of papers by others founded on the collections in the Museum, and of interesting extracts from the correspondence of the Smithsonian Institution. The more extensive and complete publications of the Museum are issued in the series of *Bulletins*. Both series are published at the expense of the Interior Department, under the direction of the Smithsonian Institution, and with the supervision of Mr. Spencer F. Baird, director of the National Museum. The present volume, containing a large proportion of articles on fishes, has been edited by Dr. Tarleton H. Bean, curator of the Department of Fishes.

A considerable number of new species of fish are described in this volume. Dr. Bean describes a new species of Coregonus from Alaska, two new species obtained by the Fish Commission, and two from Jamaica. Mr. David Jordan contributes notes on a collection of fishes from Pensacola, Florida, with two new species, one of Exocœtus; and nine other short papers on collections of fishes from Mexico, Florida, and the Mississippi. The same naturalist, in collaboration with Ch. H. Gilbert, gives four, with Seth E. Meek two, and with Joseph Swain six, notes on fishes. The volume contains several additions to the natural history of the Commander Islands in the Behring Sea. One of these is a refutation, by Leonhard Stejneger,

[1] *Proc.* of the U.S. National Museum, vol. vii. 1884. (Washington, 1885.)

of the story reported by Nordenskiöld, that a sea-cow (*Rhytina gigas*) had been seen alive in 1854. There are two plates: one of the Saccopharyngoid *Ophiognathus ampullaceus*, the other of some new shells from Alaska. The index is as complete as usual in American books of this class.

NOTES

THE following is a list of the names which the President and Council of the Royal Society will recommend to the Society at their forthcoming Anniversary Meeting on the 30th inst. for election into the Council for the ensuing year:—President, Prof. George Gabriel Stokes, M.A., D.C.L., LL.D. Treasurer, John Evans, D.C.L., LL.D. Secretaries: Prof. Michael Foster, M.A., M.D., The Lord Rayleigh, D.C.L. Foreign Secretary, Prof. Alexander William Williamson, LL.D. Other Members of the Council: Prof. Robert B. Clifton, M.A., Prof. James Dewar, M.A., Prof. William Henry Flower, LL.D., Archibald Geikie, LL.D., Sir Joseph D. Hooker, K.C.S.I., Prof. Thomas Henry Huxley, LL.D., Admiral Sir A. Cooper Key, G.C.B., J. Norman Lockyer, F.R.A.S., Prof. Henry N. Moseley, M.A., F.L.S., Prof. Bartholomew Price, M.A., Prof. Pritchard, F.R.A.S., William James Russell, Ph.D., Prof. J. S. Burdon Sanderson, LL.D., Prof. Arthur Schuster, Ph.D., Lieut.-Gen. R. Strachey, R.E., C.S.I., General James Thomas Walker, C.B.

WE greatly regret to announce the death, on Tuesday, of Dr. W. B. Carpenter, at the age of seventy-three years. His death, it would seem, was the result of an accident a few hours before. The funeral will take place to-morrow (Friday) at Highgate Cemetery. We hope next week to refer at length to the scientific work of Dr. Carpenter.

A VERY remarkable article appears in the *Nation* of October 29, on "The Private Endowment of Research," remarkable as appearing in a paper like the *Nation*, published in a "practical" country like America. "Society," the *Nation* says, "may not be prepared to interfere with the breeding of great men, but when they have once been sporadically produced there is no reason why it should not concern itself with their careful preservation. In a state of nature there is a sure process for securing the supremacy of the most perfect individuals of a race, but the qualities which make the human being great are not always qualities which fit him for taking part in the vulgar struggle for existence. . . . Huxley has well said that any country would find it greatly to its profit to spend a hundred thousand dollars in first finding a Faraday, and then putting him in a position in which he could do the greatest possible amount of work." To expose a man of genius, according to the *Nation*, "to the same harsh treatment which is good for the hod-carrier and the bricklayer, is to indulge in a reckless waste of the means of a country's greatness. But instead of the rarely-gifted being treated more favourably by the present highly scientific generation, they actually receive less consideration than they have done in many past ages of the world. . . .The waste of water-power at Niagara (the article concludes) is as nothing compared with the waste of brain-power which results from compelling a man of exceptional qualifications to earn his own living. The owner of a great estate admits that the important charities of his town have a well-founded claim upon his purse; it would not require a very great change of heart for him to feel a vivid sense of shame if a few scholars are not carrying on their researches at his expense."

THE following papers (among others) will be read at the Society of Arts during the present Session:—Apparatus for the Automatic Extinction of Fires, by Prof. Silvanus P. Thompson; The Load Line of Ships, by Prof. Francis Elgar, F.R.S.E.; Technical Art Teaching, by F. Edward Hulme, F.L.S.; The Treatment of Sewage, by Dr. C. Meymott Tidy; Calculating Machines, by C. V. Boys; The History and Manufacture of Playing Cards, by George Clulow; Domestic Electric Lighting, by W. H. Preece, F.R.S.; The Scientific Development of the Coal Tar Industry, by Prof. R. Meldola, F.C.S. The First Course of Cantor Lectures will be on "The Microscope," by John Mayall, Jun., on November 23, 30, December 7, 14, 21; the Second Course will be on "Friction," by Prof. H. S. Hele Shaw, on January 18, 25, February 1, 8; the Third Course will be on "Science Teaching," by Prof. F. Guthrie, F.R.S., on February 15, 22, March 1; the Fourth Course will be on "Petroleum and its Products," by Boverton Redwood, F.C.S., on March 8, 15, 22, 29; the Fifth Course will be on "The Arts of Tapestry-Making and Embroidery," by Alan S. Cole, on April 5, 12, 19; and the Sixth and concluding Course will be on "Animal Mechanics," by B. W. Richardson, M.D., F.R.S., on May 3, 10, 17, 24, 31. The two Juvenile Lectures on "Waves" will be given by Prof. Silvanus P. Thompson on Wednesday evenings, December 30, 1885, and January 6, 1886, for which special tickets will be issued.

Science contains accounts by Profs. Mendenhall and Paul of the attempts made to obtain records of earth tremors from the explosion at Flood Rock at the entrance to New York harbour. Arrangements to secure observations were made by the Geological Survey, together with representatives from the Naval Observatory and Signal Service. The apparatus used by the Naval Observatory party was that usual in mercury observations, and three seismoscopes, one chronograph, and a number of chronometers. Unfortunately the firing of the mine was delayed for fourteen minutes, and this prevented good observations being taken at many places. The reports so far received indicate that out of seventeen stations (three occupied by geological survey parties and fourteen co-operating with them) five watched till the disturbance came, and got more or less satisfactory observations. At one of these the rock was directly in sight, and the others were so near that the observers felt sure that it had not escaped them. Four observed and timed some slight disturbances between 11h. 3m. and 11h. 7m., and, attributing them to the explosion, ceased watching for more, and either missed it entirely or were taken by surprise; two heard nothing at all up to about 11h. 10m., and so ceased observing and missed it, and six were yet to be heard from. It will thus be perceived that the results with regard to earth-tremors, which there was every reason to expect from this colossal explosion, have been greatly diminished by the long delay in firing the mine.

PART II. of the Report of the Trinity House Committee on the recent experiments with electricity, gas, and oil as lighthouse illuminants at South Foreland, which is now issued, contains some interesting details in connection with the trials. The first portion is devoted to illustrations of the arrangements made at the South Foreland for exhibiting, observing, and measuring the lights. The second section consists of the report of Prof. W. Grylls Adams, F.R.S., of King's College, London, on the electric light apparatus employed in the production of the light shown from A tower. Following upon Prof. Adams's report is a detailed description by Baron A. de Méritens of the magneto-electric machines supplied by him for the experiments. This communication shows the principles of construction of the machines and the mechanical disposition of the magnets. Section IV. is a detailed record of the photometric observations made by Mr. Harold Dixon, of Balliol College, Oxford, and referred to by him in his report in Part I. The record consists principally of tables showing the work done on each night. Following this are some remarks upon the pentane standard devised by Mr. Vernon Harcourt, and adopted as the basis of measurement throughout the trials. Some interesting experiments to ascertain the effect of different atmospheric pressures upon this flame are described, in connection with which Mr. Harcourt and Mr. Dixon went to the summit of Ben Nevis. They found that the variation in the burning of the pentane flame due to variation in atmospheric pressure was less than had been anticipated, and that consequently no correction for such variation was necessary for the photometric results obtained at the South Foreland. Sections V., VI., and VII. deal with a very important question. A tabular statement is given illustrating the range of temperature within the gas and oil lanterns during the working of the higher power of these illuminants. In the gas lantern three of the four lens panels used to illustrate a fixed light have been seriously damaged, as shown by copies of photographs published. The lowest panel has not suffered. In the oil and electric lanterns the lenses are uninjured. The inference is that the damage has been caused by the direct or indirect action of heat. Section VIII. consists merely of a reproduction of a table from Mr. Thomas Stevenson's work on lighthouse construction and illumination in reference to the penetrating power of lights in relation to the increase of their intensity. Section IX. gives the result of observations made to ascertain the suitability of the respective illuminants for the exhibition of coloured sectors of light. The question of duration of flashes is dealt with in Section X. Under the heading "Divergence of Beam" Section XI. deals further with this question of the size of the beam. Section XII. consists of reports of experiments with sky-flashing lights, the object being to illuminate the clouds with sudden beams of light. In Section XIII. are given some memoranda for consideration in estimating the expenses of first cost and maintenance for lighthouses illuminated by gas. Section XIV. consists of a table showing the duration of fog at lighthouse and light-vessel stations on the English coasts, compiled from four years' records. Section XV. is a summarised journal of the lights shown each night during the year of the experiments.

It is stated that in order to make adequate provision for medical education in Japan, the Government intends dividing the country into six medical divisions, and to establish a medical college in each, in which the future surgeons and physicians will be trained.

On the 20th ult. Prof. Terrien de Lacouperie delivered the first of a series of lectures at University College, Gower Street, on the Science of Language and its recent progress, in connection with the languages of Indo-China. These languages, the lecturer said, are a new field of research in comparative philology which may lead to the reconsideration of several vital problems in the science of language. They offer a more satisfactory solution of these problems, and one more in accordance with the known facts of language past and present, but their influence has hitherto been injurious to the progress of linguistic science. The classification of languages into monosyllabic, agglutinative, and inflectional, is, he said, now recognised to be inadequate, and was based on a hypothesis of a primitive monosyllabic stage in the history of human speech which has never existed. The languages of Thibet, Burmah, Pegu, Siam, Annam, China, are generally called monosyllabic, and are still erroneously supposed by many to be living illustrations of the imaginary primitive language of monosyllabic roots. Such monosyllabism does not and never did exist. There are, the Professor said, three sorts of monosyllabism only—one of decay, one of writing, and one of elocution. It is to the last that the tongues of South-Eastern Asia belong, while the monosyllabism of English belongs to that of decay. The languages of the Far East, according to Prof. Lacouperie, belong to two great stocks—the Turanian and Himalayan—besides a residuum of Negrito and Papuan dialects. Turanian is represented by the great Kuenlunic branch, including (*a*) the Chinese family, (*b*) Tibeto-Burman group, (*c*) Yao-Karen group, (*d*) Dravidian family. Himalayan includes two great branches: (1) Indian, for the Kolarian languages, &c.; (2) Indo-Pacific, with four divisions—(*a*) Mōn-Taic, subdivided into two families—(1) Mōn-Annam, (2) Tai Shan—(*b*) Malayan, (*c*) Polynesian, (*d*) Micronesian. The second lecture, on the formation, evolution, and influence of Chinese, will be delivered on the 17th instant.

At a recent meeting of the Manchester Literary and Philosophical Society the special thanks of the Society were offered to Mr. Henry Wilde for the great liberality recently displayed by him in connection with the changes recently made in the building belonging to the Society, and in which it holds its meetings. When it was determined that new libraries should be erected to accommodate the rapidly increasing number of the Society's books, Mr. Wilde contributed the sum of 500*l.* to the building fund. The difference between the elegance of the new rooms and the dilapidated condition of the old ones offended Mr. Wilde's eye, and he resolved that he would, at his own expense, undertake their renovation. This he has now done at an additional cost to himself of 1100*l.* But the contribution of that money is only a part of what Mr. Wilde has done. He has personally superintended all the details of the work, rarely missing a day, during the last three months, in devoting several hours to that purpose. The results obtained evince at once the taste Mr. Wilde has displayed in regulating the style and character of the decorations.

We learn from a communication in *Naturen* that apatite has been found by Herr Enoksen, within the last few months, in certain parts of Norway where its presence had not previously been detected. The importance of this discovery to local industry is all the greater, owing to the fact that the Bamle beds, which have hitherto been the principal source from which this valuable mineral has been derived, are in the hands of a French company, which purchased them some years ago for 350,000 kroner, and still monopolises the trade. The demand for the mineral is, moreover, very considerable in Norway, one Norwegian factory, the chemical works of Stavanger, taking from the Company about 1000 tons annually, at a cost of 100 kroner per ton. According to the well-known geologist, Herr Hans Reusch, there is every reason to expect that apatite will be found with tolerable frequency in Norway when working engineers have learnt to distinguish it from the numerous valueless minerals, to which its variability of colour gives it some resemblance—for the geological formation in which it has now for the first time been detected near Stavanger, is not of uncommon occurrence in Norway. The little island of Hille, lying about five miles to the north-east of Stavanger, where Herr Enoksen has been so fortunate as to find true apatite, exhibits no products of eruption, but has extensive deposits of mica schist, largely intermixed with hornblende, and finely granulated gneiss. Here apatite is found near titanic iron in isolated masses, varying in size from a man's head to that of a nut. It occurs in various parts of the island, but its true character was not detected till Herr Enoksen showed that a piece of a stone not uncommon in the Hille schists, which had been sent to him as a scapolite, was in reality a fragment of genuine apatite. This unexpected discovery has given great impetus to the further search for this valuable mineral, which, as we learn from recent reports, has also been found in the hornblende schists of the Egersund.

An attempt has been recently made by Herr Liznar, of the Austrian Meteorological Society, to determine the daily course of cloudiness over different parts of the earth's surface. In most places there are two maxima and two minima in the day. He distinguishes four types, viz.:—(1) A maximum about midday, a minimum in the evening; this occurs, *e.g.* at Madrid (the maximum in summer becomes as late as 4 p.m.). (2) A maximum in the morning, and a minimum at midday; this is found at Los Angeles on the plateau of the Rocky Mountains. (3) Two maxima and two minima: the chief maximum in the morning, and the chief minimum in the evening; this type being met with in Vienna in winter and autumn, and in Bombay. (4) Two maxima and minima, but the chief maximum about midday and the chief minimum in the evening; this is the case at Vienna in summer and spring. The greatest amplitude of cloudiness appears at the stations on the Rocky Mountains plateaux; the sky being sometimes quite covered with clouds in the morning, and quite clear a few hours later. It is curious that the Sherman Station has a cloudiness exactly opposite in its course to that of Los Angeles. This meteorological element perhaps deserves more consideration than it has hitherto received.

A CORRESPONDENT of the *North China Herald* calls attention to a strange instance of Chinese belief and practice with regard to the human soul, which lately came under his notice. Lying awake at 3 a.m. he heard in the street close to his house two strange answering voices. Evidently two persons were engaged in this weird dramatic performance, one representing a departing soul, the other acting as the friends and relatives deprecating the departure. The first actor gave a low, prolonged cry, which was answered by a loud and earnest "Come, come." After a pause, the cry and the answering call were repeated; this went on for about ten minutes, when suddenly the inarticulate cry ceased. The second actor, in an agony of distress at the departure into the unseen of the soul he had been entreating to stay, shouted loudly in a voice, which he no doubt hoped would reach to the confines of the spirit world, "Return, return—come," at the same time calling by name. Then there was another pause, presently the low cry was heard as at a distance. "Come, come," eagerly responded the actor; and now the cry and the answer followed one another more rapidly till the cry seemed close to the caller, and in a smothered chorus as of welcome, the performance, which was probably directed by a Taoist necromancer, ceased. It is described as being strangely impressive in the stillness of the night, notwithstanding the grotesqueness of the superstition; but of course it was not known whether there was actual death in this case, within twelve hours of which the Chinese call for the soul to return, or whether it was only a case of serious illness, fainting, or collapse. This peculiar custom, it appears, varies in different parts of China. Up the Yangtsze it is usual for two women to perform the office. When a man dies suddenly the women walk through the streets, one calling out the name of the deceased, and the other responding "I am coming," the idea being to prevail on the wandering spirit of the deceased to return to its material abode, which, it is presumed, it has temporarily abandoned.

A NEW course of lectures has been established at the Collège de France on the mechanical theory of heat, magnetism, and electricity. The course will be given by M. Bouty.

ON October 22, at about 6 p.m., a slight shock of earthquake was felt at Ramsjö, in Sweden. It went from east to west, and lasted only a few seconds.

A LARGE consignment of Chinese and Japanese fish has lately reached this country, including the variegated goldfish, the nigger goldfish, the veil or fantail, the fringetail, and the nymphi. Some specimens have been on view at the Inventions Exhibition Aquarium, as well as some Russian loach and Hungarian beardfish. A large conger eel weighing 30 lbs., which had been in the tank for a long period, has just died.

MR. JOSEPH D. REDDING, a California Fish Commissioner, writes to Prof. Baird stating that he has invited investigation into the question of the devastation caused by sea-lions in the bays and seas of San Francisco, where they abound in very large numbers. They are very voracious, and it is alleged that they destroy hundreds of thousands of pounds of edible fish daily; whilst fishermen declare that their business is rapidly declining in consequence. Mr. Redding intends to present an exhaustive report to the California Legislature and to the United States Fish Commission.

THE observations that are to be undertaken by the National Fish Culture Association with a view to discovering the effect of certain influences upon marine fishes will be commenced this month. The stations from which observations will be made in the first instance are the Seven-Stones, the Royal Sovereign, and the Outer Dowsing. Besides these, other localities will be visited from time to time by observers appointed for the purpose, who will make the most complete investigations as to surface and bottom temperatures of the sea, the density and transparency of the water, the temperature of the air, &c. The question as to the declension in the yield of certain fisheries and the development of others will form the subject of inquiry, as will also the question of restoring depleted fishing-grounds to their former fertility.

A SOCIETY for popularising the use of scientific methods has been established in France under the name of the Topographical Society. It held its festive meeting on November 8 in the large hall of the Sorbonne; M. Ferdinand de Lesseps was in the chair.

WE understand that Messrs. Macmillan and Co. will shortly publish a book on Elementary Algebra, by Mr. Charles Smith, the author of well known and popular treatises on Conic Sections and Solid Geometry. After the severe remarks made by Prof. Chrystal at the last meeting of the British Association on the teaching of elementary algebra, a new work on this subject will be looked for with more than usual interest.

THE Belgian Technical Railway Commission has pronounced in favour of experiments on a large scale with steel railway sleepers. It is announced that the first trial will be made on 60 kilometres of line.

MR. ERIC STUART BRUCE has been carrying on experiments at Chatham for the English Government, with a view to the adoption of his system of military signalling. The official trial of his invention took place on October 17. To test the signalling apparatus the balloon was sent up four or five miles from Chatham and allowed to ascend 500 feet, when a series of sentences were flashed by the Morse system. The officers of the Royal Engineers who were deputed to inspect the apparatus have pronounced the experiments "eminently satisfactory." It has been suggested that this translucent balloon may be utilised for other military operations besides signalling—such as for a "point light," for concentrating forces by night; and owing to the wide area which is illuminated by the balloon, it has been proposed to use it for lighting working parties.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. Montague C. Clark; a Gannet (*Sula bassana*), British, presented by Mr. H. Archer; a Tawny Owl (*Syrnium aluco*), British, presented by Mr. J. Hillier; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. C. A. O. Marsham; a Squirrel Monkey (*Chrysothrix sciurea* ♀) from Guiana, a Ruffed Lemur (*Lemur varius* ♂) from Madagascar, a Macaque Monkey (*Macacus cynomolgus* ♀) from India, a Capercaillie (*Tetrao urogallus* ♂) from Norway, deposited; a Brazilian Tree Porcupine (*Sphingurus prehensilis*), a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*) from Brazil, two Blue-winged Teal (*Querquedula cyanoptera*) from South America, five Lesser Snow Geese (*Chen albatus*) from Alaska, purchased; five Golden-bellied Beaver Rats (*Hydromys chrysogaster*) from Australia, received in exchange.

OUR ASTRONOMICAL COLUMN

THE ROTATION PERIOD OF MARS.—The seventh volume of the *Annals* of the Leiden Observatory contains a very thorough and painstaking investigation by Prof. Bakhuyzen of the rotation period of the planet Mars. In previous determinations one of two courses has usually been adopted, either to compare drawings of Huygens or Hooke with the most recent observations attainable, or to discuss some modern series which seemed to promise to compensate for its restricted range by its greater accuracy. Prof. Bakhuyzen has, however, endeavoured to utilise the entire mass of observations at his disposal, so as to avoid the sources of error to which the other methods are liable, and he possesses a great advantage over earlier investigators, in having access not only to the numerous observations made in 1877 and 1879, but also to the great series of more than 200 drawings which Schroeter had prepared for his projected "Areographischen Beiträge," and which, becoming the property of the University of Leiden in 1876, was edited and published by Prof. Bakhuyzen in 1881. Prof. Bakhuyzen, in the reduction of these drawings, has adopted provisionally Schiaparelli's position for the pole of Mars—R.A. 317° 46'·0, Dec. 53° 25'·4, mean equinox of 1833·0—and Proctor's rotation-period—24h. 37m. 22·74s.—and deduces corrections to these elements from a comparison of the results obtained by reducing the various observations at his command with them. His first step is, from a discussion of the drawings of Kaiser, Lockyer, Lord Rosse, and Dawes, made during the oppositions of 1862 and 1864, to obtain the time of transit on January 1, 1863, of his adopted prime meridian over the Martial meridian which passes through the earth's north pole, choosing as his prime meridian the one which lies 2° to the east of the centre of Mädler's point *a*, corresponding almost exactly to Schiaparelli's *Fastigium Aryn*, or to Proctor's *Dawes Forked Bay*, he finds the time of transit over the meridian passing through the north pole of the earth on January 1, 1863, to be 20h. 27·0m. ± 4·0m, Berlin M.T. The areographic longitude of the centre of the *Oculus*, the conspicuous circular spot, called by Green the *Terby Sea*, and by Schiaparelli *Lacus Solis*, will be, with this prime meridian, 90·87°. The second section contains the determination of the areographic longitudes of ten of the most conspicuous and easily identified markings on the surface of Mars as inferred by means of the above elements from the drawings of various observers from the time of Hooke and Huygens up to 1879. For the last-named year only Schiaparelli's observations are used, but for 1877 there is an abundant supply, there being available, besides the observations of Schiaparelli, the drawings of Lohse, Green, Dreyer, and Niesten. Beer and Mädler's drawings afford material for 1830, Herschel and Schroeter give a very full series from 1777 to 1803; and Huygens and Hooke supply a few drawings from 1659 to 1683, from which the longitude of Mädler's *f*, the *Kaiser* or *Hourglass Sea*, Schiaparelli's *Syrtis Major*, can be inferred. These longitudes are discussed in the third section, and a corrected rotation period is obtained of 24h. 37m. 22·66s ± 0·0132s., a value exceedingly close to the mean of the best previous determinations, which are as follows:—

	h. m. s.
Kaiser, 1864	24 37 22·62
Kaiser, 1873	·591
Schmidt, 1873	·57
Proctor, 1868	·735

Proctor's value is clearly too large, a comparison of the mean longitudes obtained for the *Kaiser Sea* with his period showing a steady decrease for successive oppositions; the only observations which stand conspicuously out from the rest being those of Hooke, upon which he had based his determination. There can be no doubt that Prof. Bakhuyzen's value is a distinct improvement upon the earlier ones, and that its uncertainty lies only in the second place of the decimals. A table for computing the time of transit of the prime meridian over that meridian of Mars which passes through the earth's north pole, completes the memoir.

Prof. Bakhuyzen supplies also a short note as to changes on the surface of Mars. The most conspicuous of all the markings on the planet's surface has always been the *Kaiser Sea*; but the drawings of Schroeter and Herschel, as Dr. Terby has already pointed out, exhibit a second marking near it, nearly as conspicuous, and very similar in shape and size. There can be no doubt that the only modern representative of this spot is *Huggins Inlet*, Schiaparelli's *Cyclopum*, a narrow streak, by no means easily observed, and now entirely unlike the *Kaiser Sea* in shape. Prof. Bakhuyzen also considers that there is sufficient evidence for thinking that Schroeter on several occasions observed Schiaparelli's *Læstrygonum*—one of the most difficult objects on the planet—which could scarcely have been the case had it not been much more conspicuous than it has been of late years. These changes, Prof. Bakhuyzen thinks, lend a high degree of probability to the theory that certain districts of Mars are covered by liquid.

THE SPECTRUM OF THE GREAT NEBULA IN ANDROMEDA.—Mr. O. T. Sherman, assistant at Yale College Observatory, reports in *Science* (vol. vi. Nos. 138 and 141) the discovery of three bright lines in the spectrum of this nebula. Of these the most refrangible corresponds to $H\beta$, and the wave-lengths of the other two are given as 5312·5 and 5594·0. It is suggested that the second of these lines is the well-known coronal line 1474 K, and that the third is one of the feebler coronal lines which Prof. Young observed in the 1869 eclipse, viz. the one at 1250 ± of Kirchhoff's scale. The observation, if confirmed, will go far to settle the disputed question as to whether the *Nova* is really or only apparently connected with the nebula, for two bright lines, of which one is probably 1474 K, have been observed in the spectrum of the former at the Royal Observatory, Greenwich.

THE WEDGE PHOTOMETER.—Dr. Wilsing in the *Astronomische Nachrichten*, No. 2680, criticises at considerable length several points with regard to Prof. Pritchard's use of the wedge photometer at the Oxford Observatory. Dr. Wilsing considers that Prof. Pritchard's investigations as to the figure of the wedge and its selective absorption leave nothing to be desired, but that the state of our knowledge of the physiological side of the question is still very incomplete. Experiments which Dr. Wilsing has made with two wedges of his own have convinced him that the variations in the sensibility of the eye are neither slight nor unimportant, and that they occasion discordances in the observations considerably greater than Prof. Pritchard is inclined to admit. Dr. Wilsing also finds that comparisons of differently coloured stars give results not directly comparable with eye estimations. He objects to the use of the method of limiting apertures for the determination of the value of the wedge constant, and points out that the influence of the intensity of the background affects Prof. Pritchard's magnitudes of the fainter stars very perceptibly. Despite all these drawbacks, however, he regards the wedge photometer as a useful addition to our equipment.

Mr. Chandler, who must at Harvard College enjoy special facilities for making himself well acquainted with the working of different forms of photometers, has recently expressed his preference for Argelander's method. There can, however, be no doubt but that the labours of Profs. Pritchard and Pickering have greatly advanced our knowledge of the comparative brightnesses of the northern stars.

PHOTOGRAPHING THE CORONA IN FULL SUNSHINE.—Mr. W. H. Pickering, of Harvard College, made a series of attempts during the partial eclipse of last March 16, to obtain a photograph of the corona. In this he was quite unsuccessful, for, though his plates showed several corona-like markings, they were clearly not due to the true corona, as they were found in front of the moon as well as on the sun's limb. From this Mr. Pickering was evidently led to conclude that the results which Dr. Huggins had obtained were probably of a similar character, and he expressed as much in a letter to *Science*. Dr. Huggins in reply pointed out that Mr. Pickering's method was faulty and was calculated to produce such false images. The latter, therefore, somewhat modified his apparatus, without, however, altering the two points which Dr. Huggins considered most erroneous—viz. the use of an object-glass instead of a reflector, and the placing his drop-slit close in front of the object-glass instead of in its primary focus. The result has been that he has obtained photographs free from false coronæ, but showing no real ones. At the same time he has made experiments which convince him that to produce a perceptible image of a coronal rift it is necessary to be able to discriminate between degrees of illumination which do not differ from each other by more than one-tenth the intrinsic brilliancy of the full moon. He considers that the eye is more able to detect small differences of light than a photograph is, and states that the moon cannot be photographed in full daylight, even though it may be easily seen. His investigations also lead him to think that even in the clearest weather the atmospheric illumination is 300 times as bright as it should be for it to be possible to obtain any image of the corona. To these points Dr. Huggins has replied in the *Observatory* for November. Dr. Huggins states that he has had no difficulty at all in photographing the moon in full sunshine, and that the observations of Prof. Langley and others of Mercury and Venus, which have been seen as black disks before they reach the sun, proves that the corona must have a sensible brightness as compared with the atmospheric illumination.

He also points out that Mr. Pickering fails to obtain any trace on his photographs even of the defects of his own instrument. Dr. Huggins declines further discussion, preferring to wait the result of the work now being carried on by Mr. Ray Woods at the Cape Observatory. Mr. Pickering replies in *Science* for October 23, admitting the possibility of photographing the moon in full sunshine, but contending that these very photographs of the moon supply an additional proof of his opinion that the light of the atmosphere near the sun is more than 300 times too intense for it to be possible to obtain a photograph of the corona, since the sky light near the sun was fifty times as bright as that near the moon, and coronal photographs, to be of any use, should be able to record differences of illumination of only one-tenth the brightness of the full moon.

He explains the visibility of Venus and Mercury as being caused by the refraction of the sun's light through their atmospheres, the black disk being thus surrounded by a narrow luminous ring.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *NOVEMBER* 15-21

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 15

Sun rises, 7h. 21m.; souths, 11h. 44m. 48·4s.; sets, 16h. 9m.; decl. on meridian, 18° 37′ S.: Sidereal Time at Sunset, 19h. 49m.

Moon (one day after First Quarter) rises, 13h. 18m.; souths, 18h. 37m.; sets, 0h. 3m.*; decl. on meridian, 8° 43′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	9 6	12 54	16 42	24 8 S.
Venus	11 28	15 2	18 36	25 59 S.
Mars	23 40*	6 46	13 52	12 2 N.
Jupiter	2 14	8 23	14 32	1 5 N.
Saturn	18 48*	2 56	11 4	22 20 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Occultation of Star by the Moon

Nov.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
17	B.A.C. 8365	6½	22 41	23 44	166 298

Phenomena of Jupiter's Satellites

Nov.	h. m.		Nov.	h. m	
15	5 0	IV. occ. reap.	17	4 35	II. tr. ing.
16	2 45	III. ecl. disap.	20	6 56	I. tr. ing.
16	5 51	III. ecl. reap.	21	3 16	I. ecl. disap.
16	6 47	III. occ. disap.	21	6 34	I. occ. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

GEOGRAPHICAL NOTES

The last number of the *Izvestia* of the Russian Geographical Society (xxi. 3) contains a variety of interesting papers. M. Ivanoff describes some Turkestan antiquities: namely, the Akhyr-tash, situated at the foot of the Alexander ridge, twenty-seven miles from Aulie-ata, one of the grandest buildings of antiquity, which covers nearly 20,900 square yards, and must have been some projected immense temple or palace; it was built from immense stones, weighing about one ton each, and brought from Tash-tube. M. Ivanoff gives for the first time a plan and a detailed description of the ruins of this immense building. Stone idols on the Issyk-kul, as also a burial-ground on the shores of the same lake, are described and represented by drawings. The whole is a most valuable contribution M. Trusman's paper on Finnish elements in the Gdov district of St. Petersburg will be welcome to Russian archæologists. Capt. Gedeonoff gives a list of forty-three places in the Trans-caspian region, whose positions have been determined by means of astronomical observations, as also their heights, determined by barometrical measurements. We notice the following: Khiva (house of Mat-murat), 41° 23′ 0″·1 N. lat., 60° 22′ 18″·9 E. long., 351 feet above the sea-level; Merv (Koushut-khan-kala), 37° 35′ 37″·6 N. lat., 61° 50′ 27″·9 E. long., 565 feet; and Tchardjui, 39° 1′ 33″·8 N. lat., 63° 36′ 12″·9 E. long., 433 feet. M. Konshin's paper on the Sary-kamysh lake basin and the western basin deserves more than a short notice, as it sums up the latest researches in this region, and presents the whole question as to the bed of the Amu-daria in quite a new light. A report on cartographical work in Russia in 1884 will be summed up under a separate head, as also two letters from Col. Prjevalsky and M. Potanin. Finally, the same issue contains two most valuable maps, by Gen. Tillo. One of them, on a larger scale, gives the lines of equal magnetic intensity, full and horizontal only, for Russia in Europe, reduced to the year 1880. On this map all places where observations have been made, as also where anomalies have been observed, are marked. Two other maps, on a smaller scale, give the lines of equal secular variation, both of the horizontal and of the total magnetical intensity. All three have explanations in German. These maps thus complete the remarkable work on "Earth-Magnetism in Russia," undertaken a few years since by M. Tillo, and already mentioned in Nature.

The last news from M. Potanin's expedition is embodied in a letter, dated San-chuan, January 25, and published in the last issue of the St. Petersburg *Izvestia* (xxi. 3). Leaving San-chuan on November 14, M. Potanin followed the right bank of the Hoang-ho up to He-cheu. The same red sandstones and conglomerates, covered with loess, were met with; the ridge which separates the Hoang-ho from the Tao-ho, intersected by deep ravines, is all covered with cornfields and villages; the soil abounding with moisture, villages are situated as high as 2000 feet above the bottom of the valleys. Crossing the Tao-ho and next the Da-sya-ho, the little half-ruined town of He-cheu was reached. The Da-sya-ho River is formed by the junction of three rivers—the Huishu, the Tumun, and the Leu-guan—situated 70 li above the town. This last river was followed by the expedition, and its source was reached after a two days' march. Its valley is wide and well-peopled in its lower half, the upper one being a mere gorge thickly covered with brush-wood, and quite unpeopled. Crossing a ridge at the sources of the Leu-guan and its tributary, Urunka, the broad valley of the Tchitai was next reached. Its banks consist also of sandstones and conglomerates, and it is thickly peopled with Salars, its upper part being occupied by Tanguts. Descending this valley, a two days' march brought the expedition to the confluence of the Tchitai with the Yellow River; and another two days' march brought them to San-chuan. On this stretch the Yellow River flows in a narrow gorge between steep crags of the red sand-stones and conglomerates, and the road ascends these crags or follows their slope on narrow wooden balconies, or by flights of steps cut in the hard rock. The right bank of the river is inhabited by Salars. They have maintained their Turkish language in great purity. The men wear a Chinese dress, but the women wear broad trousers, and a broad overcoat with sleeves, and a pointed bonnet which covers the upper part of the back. They are all Mussulmans, but their mosques are of Chinese architecture, and are decorated with dragons, lions, and tigers. Above its gorge the Yellow River flows through a depression seven miles long and less than two miles wide, which has received the name of San-tchuan, or Gurban-tala, and is peopled exclusively by Mongolian Shirongols. Their central village is Ni-ja. The Shirongols seem to belong to the same stem as that described by M. Prjevalsky under the name of Dalda in the vicinity of Kuku-nor. Both are called Tu-jen by the Chinese. If this supposition is correct, they would appear to occupy the territory from the longitude of He-cheu to that of Gan-cheu. They speak Mongolian, with an addition of Chinese words, but have some words of their own which must be remains of the language they have spoken in their former territory, the Urdus. Their dress is Chinese, but the women have maintained the same trousers as the Salars, and their houses have much likeness with those of these last. They live on agriculture and gardening. All the religions of the region are met with among them. Around He-cheu they are all Mussulmans; but families having several male children send one of them to a Lamaite monastery so as not to divide their land-holdings too greatly, and so a class of Buddhist Lamas has arisen. Those who have received Chinese instruction follow the teachings of Confucius, while the remainder go indifferently to Buddhist or Chinese temples, and many have Shamanist divinities. As to M. Berezovsky, he has left the expedition and has taken another route, *viâ* Hoy-syan; he proposes to rejoin MM. Potanin and Skassi on their way to the south.

THE expedition which is reported to have been massacred in New Guinea was sent out by the Geographical Society of Australasia, founded in May 1883. The commander, Capt. Henry Charles Everill, had been selected from a number of candidates, and his staff included a naturalist, a surgeon, two sub-leaders, one on land and the other on sea, a photographer, three natural history collectors, a surveyor, an engineer, and a "general utility" volunteer. Very full instructions were drawn out for the expedition, while considerable discretion was left to the leader to adapt his operations to circumstances. The instructions included directions not only for surveying work, but for observations on the natives, on zoology, botany, and geology, with directions for the collection and preservation of specimens. The expedition was to enter the Aird River, which is probably only an east arm of the Fly River. As a matter of fact, a telegram of September 22 announced the arrival of the *Bonito* (the vessel in which the expedition sailed from Sydney) in the Fly River. It was to penetrate as far as possible into the interior. The Australasian Society contributed 500*l*. to the expedition of Mr. H. O. Forbes, who, according to latest news, was at Port Moresby preparing to penetrate into the interior. Happily the report of the massacre is discredited by the British resident on Thursday Island.

THE Geographical Society of Lisbon passed a resolution at its last meeting asking the Portuguese Government to make a money grant by way of remuneration to the explorers MM. Capello and Ivens, and to pay the cost of publishing not less than 5000 copies of the account of their journey. It was also resolved to address every commercial association throughout the country pointing out the necessity of establishing a company or society for the purpose of investigating colonial markets hitherto imperfectly known, but of which MM. Capello and Ivens are showing the importance.

AT the last meeting of the Paris Society of Commercial Geography on the 20th ult., the Burmese Envoy being present, M. Bran de Saint Pol Lias described his recent journeys in Indo-China, which appear not to have extended far beyond Saigon, Cambodia, and the delta of the Red River. Indeed, travel even in these comparatively frequented parts of the peninsula must have been difficult when the traveller was there, for the greater part of Tonquin and Cambodia was in rebellion at the time of his visit.

THE *Bulletin* (2^e trimestre, 1885) of the Paris Geographical Society, just published, contains a long report on the labours of the society, and on the progress of the geographical sciences, by M. Maunoir, the secretary. The work is, as usual, well and thoroughly done. The only other paper in the number is a description of the regions of Algeria traversed by the meridian of Paris, by Commander Derrien. This is accompanied by a map, and describes in succession, and with great detail, their orography, hydrography, geology, military roads, meteorology, military and administrative divisions, and also discusses the origin of the tribes of the Jebel Amour.

THE Geographical Society of Tokio appears to be steadily pursuing its work. The recent numbers of its *Journal*, which we have before us, show much activity in regions around Japan. Amongst the papers in the sixth volume we notice the following:—The five races of the Chinese Empire, and their ancient progress, by Mr. Otori; the interior of Northern Corea, by Mr. Kaizu; travels in Siam; notes on Thibet (compiled from European sources); Formosa under the Chinese; Manchuria: recent events in Annam; travels in South-eastern Russia; the salt-tax in China; colonisation in Saghalien (a review); Formosa during the Dutch occupation; historical notes on the relations between Russia and China; notes on the aboriginal language of Formosa, with a considerable vocabulary; Candahar and the Lower Cabul Valley, with a sketch map; the mines of Central Japan, with a map, and various other minor communications. The first number of the tenth volume contains a paper by Mr. Akamatsu on the origin and condition of the Chinese emigrants to the Philippines, based apparently on the writings of Prof. Blumentritt on the subject; and one on the longitude of Japan, by Mr. Arai, the head of the meteorological bureau. The *Journal* is printed in Japanese, but a short table of contents is appended in English.

THE leading paper in the current number (Heft 3, Band viii.) of the *Deutsche Geographische Blätter*, the organ of the Geographical Society of Bremen, is one by Leonard Steineger, describing a voyage around Behring Island, off the coast of Kamchatka, in the autumn of 1882. It describes at some length the incidents of the voyage, the capabilities of the island, &c. The writer visited and describes the ruins of the hut in which Behring and his companions wintered 141 years previously, and where the traveller himself died, and was buried. Dr. von Steiner compiles from Mr. Im Thurn, an account of the Indians of Guiana. The usual geographical news concludes the number.

MR. SCOTT, of the Indian Survey Department, recently delivered a lecture at Calcutta on the transfrontier surveys of India, in which he pointed out that 20,000 square miles on the immediate north-western frontier needed exploration. Here lie the Kafila routes into Afghanistan, which he much regretted had not been used for the advance into Afghanistan instead of the hot and thirsty Bolan Pass. He suggested that the rules against British officers crossing the frontier should be relaxed, and that they should be permitted to accept invitations, with a guarantee of safety, by native officers to their homes across the border.

THE death of Col. Obrigado, of the Argentine Army, on September 22 at Buenos Ayres is announced. In recent years he had made many scientific explorations on the coasts and in the interior of Patagonia. He traversed the forests in the basins of the Negro, Limay, and Nanquen rivers, which had never been explored before; and several places in these regions now bear his name. His death was due to ill-health, caused by his journeys in Patagonia.

THE last issue of the *Mittheilungen* of the Geographical Society of Vienna contains two papers on the Carolines; one by Prof. Blumentritt describing the historical relations of Spain to the archipelago. He makes more interesting quotations from books used in Spanish schools, in which the Carolines are mentioned amongst the colonies of Spain, and the usual elementary school-book information is given about them. The secretary to the Society also gives a map of the group, with much geographical and other information respecting them. Herr Jülg concludes his paper on the erosive action of the sea, and the usual current geographical information brings the number (Band xxviii., No. 10) to a conclusion.

THE SCOTTISH METEOROLOGICAL SOCIETY

AT a meeting of the Directors of the Ben Nevis Observatory held on October 30, it was intimated that during the summer Prof. Ewing, of Dundee, had visited the Observatory to make arrangements for the observations on earthquakes and earth movements which it had been resolved to carry on there. Prof. Vernon Harcourt and Mr. Harold Dickson, both of Oxford, also spent some time at the Observatory conducting experiments and observations on the intensity of light in flames, it being necessary, in connection with the important practical question of a satisfactory determination of the light-giving qualities of coal gas supplied to the public, to make experiments on such a situation as Ben Nevis, where barometric pressure is low. Mr. H. N. Dickson resided two months at the Observatory, being chiefly engaged in carrying out, under the superintendence of Prof. Tait and Mr. Buchan, a valuable series of observations and experiments on the methods of observing the temperature and humidity of the air. For this purpose the season was a singularly suitable one, on account of the extremes of temperatures and humidities the weather presented during the summer on the Ben. As regards the humidity, where there were of course abundant opportunities of studying the behaviour of the instruments in an atmosphere completely saturated through a wide range of temperature, many cases occurred of excessive and protracted dryness of the atmosphere. On one occasion, in September, no deposition of dew took place on

Prof. Chrystal's condensation hygrometer, though its temperature was lowered to 9°·0. These quite exceptional arid states of the air on Ben Nevis during the past summer are of the greatest interest, especially in their relations to the unprecedentedly severe early frosts which were so destructive to the potato and cereal crops over extensive breadths of the country during September. It was reported that since the middle of August subscriptions to the amount of about 300*l.* had been already received from the original subscribers, and it was resolved to make the claims of the Observatory more widely known. At the same meeting the Council resolved that the discussion of the observations of the temperature of the sea round Scotland be undertaken by the Scottish Marine Station at Granton chiefly with the view of constructing isothermal maps of the sea for each month round the Scottish coasts. The Secretary reported that he had during the summer inspected twenty-six of the Society's stations. The Duke of Buccleuch, and Messrs. Donald Beith, W.S.; Robert Irvine of Royston; B. N. Peach, Geological Survey; and John Horn, also of the Geological Survey, were elected members of the Society.

ON THE INTELLIGENCE OF THE DOG[1]

THE man and the dog have lived together in more or less intimate association for many thousands of years, and yet it must be confessed that they know comparatively little of one another. That the dog is a loyal, true, and affectionate friend must be gratefully admitted, but when we come to consider the psychical nature of the animal, the limits of our knowledge are almost immediately reached. I have elsewhere suggested that this arises very much from the fact that hitherto we have tried to teach animals, rather than to learn from them—to convey our ideas to them, rather than to devise any language or code of signals by means of which they might communicate theirs to us. The former may be more important from a utilitarian point of view, though even this is questionable, but psychologically it is far less interesting. Under these circumstances it occurred to me whether some such system as that followed with deaf mutes, and especially by Dr. Howe with Laura Bridgman, might not prove very instructive if adapted to the case of dogs. I have tried this in a small way with a black poodle named "Van." I took two pieces of cardboard about 10 inches by 3, and on one of them printed in large letters the word "food," leaving the other blank. I then placed two cards over two saucers, and in the one under the "food" card put a little bread and milk, which "Van," after having his attention called to the card, was allowed to eat. This was repeated over and over again till he had had enough. In about ten days he began to distinguish between the two cards. I then put them on the floor and made him bring them to me, which he did readily enough. When he brought the plain card I simply threw it back, while, when he brought the food card, I gave him a piece of bread, and in about a month he had pretty well learned to realise the difference. I then had some other cards printed with the words "out," "tea," "bone," "water," spelt phonetically, so as not to trouble him by our intricate spelling, and a certain number also with words to which I did not intend him to attach any significance, such as "nought," "plain," "ball," &c. "Van" soon learned that bringing a card was a request, and soon learned to distinguish between the plain and printed cards; it took him longer to realise the difference between words, but he gradually got to recognise several, such as "food," "out," "bone," "tea," &c. If he was asked whether he would like to go out for a walk, he would joyfully pick up the "out" card, choosing it from several others, and bring it to me, or run with it in evident triumph to the door. I need hardly say that the cards were not always put in the same places. They were varied quite indiscriminately and in a great variety of positions. Nor could the dog recognise them by scent. They were all alike, and all continually handled by us. Still I did not trust to that alone, but had a number printed for each word. When, for instance, he brought a card with "food" on it, we did not put down the same identical card, but another bearing the same word, when he had brought that a third, then a fourth, and so on. For a single meal, therefore, eighteen or twenty cards would be used, so that he evidently is not guided by scent. No one who has seen him look down a row of cards and pick up the one he wanted could, I think, doubt that in bringing a card he feels he is making a request, and that he can not only distinguish one card from another, but also associate the word and the object. This is, of course, only a beginning, but it is, I venture to think, suggestive, and might be carried further, though the limited wants and aspirations of the animal constitute a great difficulty. My wife has a very beautiful and charming collie, "Patience," to which we are much attached. This dog was often in the room when "Van" brought the food card, and was rewarded with a piece of bread. She must have seen this thousands of times, and she begged in the usual manner, but never once did it occur to her to bring a card. She did not touch or indeed even take the slightest notice of them. I then tried the following experiment:—I prepared six cards about 10 inches by three, and coloured in pairs—two yellow, two blue, and two orange. I put three of them on the floor, and then holding up one of the others, endeavoured to teach "Van" to bring me the duplicate. That is to say, that if the blue was held up, he should fetch the corresponding colour from the floor; if yellow, he should fetch the yellow, and so on. When he brought the wrong card he was made to drop it, and return for another till he brought the right one, when he was rewarded with a little food. The lessons were generally given by my assistant, Miss Wendland, and lasted half an hour, during which time he brought the right card on an average about twenty-five times. I certainly thought that he would soon have grasped what was expected of him. But no. We continued the lessons for nearly three months, but as a few days were missed, we may say for ten weeks, and yet at the end of the time I cannot say that "Van" appeared to have the least idea of what was expected of him. It seemed a matter of pure accident which card he brought. There is, I believe, no reason to doubt that dogs can distinguish colours; but as it was just possible that "Van" might be colour blind, we then repeated the same experiment, only substituting for the coloured cards others marked respectively I., II., and III. This we continued for another three months, or, say, allowing for intermissions, ten weeks, but to my surprise entirely without success. I was rather disappointed at this, as, if it had succeeded, the plan would have opened out many interesting lines of inquiry. Still in such a case one ought not to wish for one result more than another, as of course the object of all such experiments is merely to elicit the truth, and our result in the present case, though negative, is very interesting. I do not, however, regard it as by any means conclusive, and should be glad to see it repeated. If the result proved to be the same, it would certainly imply very little power of combining even extremely simple ideas. I then endeavoured to get some insight into the arithmetical condition of the dog's mind. On this subject I have been able to find but little in any of the standard works on the intelligence of animals. Considering, however, the very limited powers of savage men in this respect—that no Australian language, for instance, contains numerals even up to four, no Australian being able to count his own fingers even on one hand—we cannot be surprised if other animals have made but little progress. Still, it is surprising that so little attention should have been directed to this subject. Leroy, who, though he expresses the opinion that "the nature of the soul of animals is unimportant," was an excellent observer, mentions a case in which a man was anxious to shoot a crow. "To deceive this suspicious bird, the plan was hit upon of sending two men to the watch-house, one of whom passed on, while the other remained; but the crow counted and kept her distance. The next day three went, and again she perceived that only two retired. In fine, it was found necessary to send five or six men to the watch-house to put her out in her calculation. The crow, thinking that this number of men had passed by, lost no time in returning." From this he inferred that crows could count up to four. Lichtenberg mentions a nightingale which was said to count up to three. Every day he gave it three mealworms, one at a time; when it had finished one it returned for another, but after the third it knew that the feast was over. I do not find that any of the recent writers on the intelligence of animals, either Buchner, or Peitz, or Romanes, in either of his books, give any additional evidence on this part of the subject. There are, however, various scattered notices. For instance, there is an amusing and suggestive remark in Mr. Galton's interesting "Narrative of an Explorer in Tropical South Africa." After describing the Damara's weakness in calculations, he says:—"Once while I watched a Damara floundering hopelessly in a calculation on one side of me, I observed 'Dinah,' my spaniel, equally embarrassed on the other; she was overlooking half a dozen of her new-born puppies,

[1] Abstract of paper by Sir John Lubbock, Bart., M.P., F.R.S., read at the Aberdeen meeting of the British Association.

which had been removed two or three times from her, and her anxiety was excessive, as she tried to find out if they were all present, or if any were still missing. She kept puzzling and running her eyes over them backwards and forwards, but could not satisfy herself. She evidently had a vague notion of counting, but the figure was too large for her brain. Taking the two as they stood, dog and Damara, the comparison reflected no great honour on the man." But even if "Dinah" had been clear on this subject, it might be said that she knew each puppy personally, as collies are said to know sheep. The same remark applies generally to animals and their young. Swans, for instance, are said to know directly if one of their cygnets is missing, but it is probable that they know each young bird individually. This explanation applies with less force to the case of eggs. According to my bird-nesting recollections, which I have refreshed by more recent experience, if a nest contains four eggs, one may safely be taken; but if two are removed, the bird generally deserts. Here, then, it would seem as if we had some reason for supposing that there is sufficient intelligence to distinguish three from four. An interesting consideration arises with reference to the number of the victims allotted to each cell by the solitary wasps. One species of Ammophila considers one large caterpillar of *Noctua segetum* enough; one species of Eumenes supplies its young with 5 victims; another 10, 15, and even up to 24. The number appears to be constant in each species. How does the insect know when her task is fulfilled? Not by the cell being filled, for if some be removed she does not replace them. When she has brought her complement she considers her task accomplished, whether the victims are still there or not. How, then, does she know when she has made up the number 24? Perhaps it will be said that each species feels some mysterious and innate tendency to provide a certain number of victims. This would, under no circumstances, be any explanation; but it is not in accordance with the facts. In the genus Eumenes the males are much smaller than the females. Now, in the hive-bees, humble-bees, wasps, and other insects, where such a difference occurs, but where the young are directly fed, it is of course obvious that the quantity can be proportioned to the appetite of the grub. But in insects with the habits of Eumenes and Ammophila the case is different, because the food is stored up once for all. Now, it is evident that if a female grub was supplied with only food enough for a male she would starve to death; while if a male grub were given enough for a female it would have too much. No such waste, however, occurs. In some mysterious manner the mother knows whether the egg will produce a male or female grub, and apportions the quantity of food accordingly. She does not change the species or size of her prey; but if the egg is male she supplies 5; if female, 10 victims. Does she count? Certainly this seems very like a commencement of arithmetic. At the same time it would be very desirable to have additional evidence how far the number is really constant. Considering how much has been written on instinct, it seems surprising that so little attention has been directed to this part of the subject. One would fancy that there ought to be no great difficulty in determining how far an animal could count; and, whether, for instance, it could realise some very simple sum, such as that two and two make four. But when we come to consider how this is to be done the problem ceases to appear so simple. We tried our dogs by putting a a piece of bread before them and preventing them from touching it until we had counted seven. To prevent ourselves from unintentionally giving any indication we used a metronome (the instrument used for giving time when practising the pianoforte), and to make the beats more evident we attached a slender rod to the pendulum. It certainly seemed as if our dogs knew when the moment of permission had arrived; but their movement of taking the bread was scarcely so definite as to place the matter beyond a doubt. Moreover, dogs are so very quick in seizing any indication given them, even unintentionally, that, on the whole, the attempt was not satisfactory to my mind. I was the more discouraged from continuing the experiment in this manner by an account Mr. Huggins gave me of a very intelligent dog belonging to him. A number of cards were placed on the ground, numbered respectively 1, 2, 3, and so on up to 10. A question is then asked: the square root of 9 or 16, or such a sum as $6 \times 52 - 3$. Mr. Huggins pointed consecutively to the cards, and the dog barked when he came to the right one. Now Mr. Huggins did not consciously give the dog any sign, yet so quick was the dog in seizing the slightest indication, that he was able to give the correct answer. This observation seems to me of great interest in connection with the so-called "thought-reading." No one, I suppose, will imagine that there was in this case any "thought-reading" in the sense in which this word is used by Mr. Bishop and others. Evidently "Kepler" seized upon the slight indications unintentionally given by Mr. Huggins. The observation, however, shows the great difficulty of the subject. I have ventured to bring this question before the Section partly because I shall be so much obliged if any lady or gentleman present will favour me with any suggestions; and partly in hope of inducing others with more leisure and opportunity to carry on similar observations, which I cannot but think must lead to interesting results.

Dr. Flower remarked that the crowded state of the room was sufficient evidence of the interest taken in whatever of the numerous subjects Sir John Lubbock cared to enlighten them upon. Sir John Lubbock was unable to make his dog count seven, but a dog at a place where he (Dr. Flower) was living recently certainly knew when the seventh day of the week came. The dog, most eager on every other day of the week to go for a walk, betrayed no desire to go on Sunday when his master took up his hat and stick to go to church. It struck him that the method which Sir John had adopted was the only one by which they could put themselves in relation to the minds of these animals—namely, the method of kindness and encouragement. Too many had tried to do these things by a system of intimidation and cruelty, but he did not think they could really know what dogs could do, and bring out their faculties, without patience and perseverance, encouragement, and uniform kindness.

Miss Catherine Rae explained the way in which she got a dog, within three weeks, to ring a bell. She began by letting "Tiny" smell the bone of a mutton chop, and then tied the bone to the string of the bell. At first "Tiny" was in a great tremor, but, by taking her very kindly and stroking her, she found that she could induce her to pull at the bone and so to ring the bell. After that she tied a small piece of wood to the string, but the dog would not pull it. At last she pulled her gently back till the bell rang, and in this way, in the short course of three weeks, with not more than one or two lessons a day, the dog would go and ring the bell by being told—"'Tiny,' go and ring the bell." At the end of three weeks she gave an evening party, and during the evening they were all electrified by the sudden and violent ringing of the bell. "Tiny" had been neglected to be indulged with any tit-bit, and had taken this means of receiving attention.

Miss Becker said, with regard to the experiments with the crow mentioned by Sir John, to show that it could not count beyond three, that something of the same kind might happen with a person. Place three eggs upon the table, and any one could say there were three; but if there were twelve he would require to count them to be sure of the number.

Mr. C. C. Walker gave an instance of a dog being taught politics. He belonged to a family where Liberal politics prevailed, and the dog showed his sympathy by growling fearfully when the name of "Dizzy" was mentioned, and at the name of his master giving expression to unbounded delight. Similar demonstrations at public meetings, he added, were often made with as little intelligence as those of the dog.

Some other remarks were made, one gentleman suggesting that as long as the dog was ignorant of the words "one," "two," "three," "four," he would not be able to count or get beyond the mere perception of magnitude.

Sir John Lubbock thought with reference to the question of Sunday that there were so many slight indications in the household generally to distinguish the day that he had never been able to regard that as proof of a dog counting, although it was a very interesting fact in itself. As regards several of the other cases they were clever tricks, but his suggestion was to operate in exactly the opposite direction; not to teach the dog, but to enable the dog to communicate with us.

NITROGEN IN THE SOIL

EACH of the elements required for building up the frame of animals and plants is of equal importance from a scientific standpoint, but in agriculture the various salts and substances which yield food for crops or for cattle must necessarily be valued according to their cost. There are exceptions to this rule, no doubt. Gypsum is a cheap manure, but it has sometimes doubled the clover crop, and kainit salts are comparatively cheap. Yet for some crops, especially potatoes, in cases of a deficient supply of potash in the soil, they have sometimes proved invaluable. In general, however, cost and efficiency are closely associated, and as plants and animals are almost alike in their chemical composition the same rule as to the value of their constituents holds good. You may purchase starch and the carbo-hydrates at a much lower rate than the nitrogenous substances in food. Turnips, bread fruit, and bananas, consisting chiefly of carbo-hydrates, are sold by their respective growers at a very different and much lower price than milk or peas, which are rich in albuminous elements. In every form nitrogen is always comparatively costly. The albumen in eggs, the fibrine in cereals, the casein in milk, and the legumin in peas and beans, all owe their importance and cost to this particular element, which is the source of force and vigour, of the labour of the hardest-worked cattle and men, of lean meat and muscle.

Considering the limited supply of nitrogen and the cost of obtaining it, it is not surprising that it should often be present in cultivated soils in quantities insufficient for a full crop, and that the land, when dressed with salts of nitrogen, should answer to their touch as a horse does to the spur. In the Rothamsted experiments the unmanured field yielded for years about fourteen bushels, or half a crop, till a dressing of nitrogen was given to it, when immediately the crop was doubled, nitrogen having been, as it often is in clay soils, the one thing needful to a full crop. Sir John Lawes has been sometimes asked by American farmers how to restore the exhausted fertility of their fields, so that the land, yielding fourteen bushels per acre, which is about the average of corn-exporting countries, might be induced to return twice as much. It is fortunate for English farmers that Sir John can only send advice into the far West ; he cannot send nitrogen.

Some years ago the agricultural community was flattered by the immediate prospect of a never failing supply of nitrogen. The marvels of chemistry and analysis had recently been unfolded by the writings of Sir H. Davy and Baron Liebig, and the efficacy of guano had accustomed farmers to the new method of supplying nitrogen to the land in concentrated forms and from sources outside the farmyard. Then came the promise of obtaining nitrogen from the atmosphere. The agricultural classes are rarely much moved by anything but bad weather and falling prices, and the chemists had explained to them that the nitrogen of the atmosphere, existing as it does in a free state mixed with oxygen, was not available for agricultural purposes. If it could be induced, they were told, to enter into combination with hydrogen the result would be ammonia, an invaluable manure. This was understood by farmers, and a great sensation was occasioned among them when Mr. Nasmyth, the inventor of the steam hammer, proposed to control the supply of the most costly of plant constituents by knocking it out of the atmosphere. It is easy to see that if Mr. Nasmyth had succeeded in knocking nitrogen and hydrogen into combination at a moderate cost, a revolution in the price of manures and of food must have speedily occurred.

But as the plan failed and as plants still "live and move and have their being" in the midst of an element which they cannot feed on, it was certainly surprising to learn lately that nitrogenous manures had ceased to produce their accustomed effect. The phenomenon occurred at the Duke of Bedford's experimental farm at Woburn, where, according to official statements, the yield of wheat manured by the dung of animals fed on maize proved as abundant as the crop which followed from manure produced by the feeding of cotton cake, which enriches the excreta with far more nitrogen than that produced by feeding maize.

The Woburn experiments were instituted by the Royal Agricultural Society and were placed under the management of its chemist, the late Dr. Voelcker, for the purpose of testing the value of manure obtained by the consumption of different kinds of food and to compare the effects of such manures with those of artificial manures. It is evident that in such a comparison the land to which the various fertilisers were applied should have been of similar quality. But there are other disturbing causes which may vitiate experiments of this kind, and these were not at first generally recognised. The mistake occurred in some rotation experiments in which the manure derived from cotton cake containing about 40 per cent. of nitrogenous constituents was compared in its results with that obtained from maize, a cereal containing only 10 per cent. of albuminoids. The results of these experiments were known to the agricultural community before the report of Dr. John Voelcker, who has succeeded his late father as chemist to the Royal Agricultural Society, had been made, and much surprise was expressed that at the close of the second rotation the cotton cake had not shown any decided superiority over the maize. It has been recently explained in an official report on the "Objects, Plan, and Results of the Woburn Experiments," that this was "probably due to the large amount of unexhausted manure in the land." Before commencing experiments, therefore, on the comparative value of manures the land should be exhausted by repeated scourging crops, as at Rothamsted, where in some cases the deep-rooting Bokara clover has been grown for the special purpose of reducing the fertility of the soil to *nil*.

It has long since been established that nitrogen is neither absorbed by plants from the atmosphere nor conveyed into the soil to any appreciable extent in any way except by the direct application of manure : still there are some crops which collect nitrogen and leave the surface-soil richer than before. Red clover is usually grown as a preparation for wheat, and although clover hay must necessarily withdraw a great deal of plant-food from the soil, it does not prove exhaustive in practice because the deep and fleshy roots of the plant collect nitrogen from the subsoil and, in their decay, supply it to the growing wheat-crop. Under such circumstances a strong nitrogenous manure may not be required, and may perhaps prove less desirable than a weak manure containing less nitrogen. Enough has been said to show that the field experiments which are now becoming popular, and which are being instituted at many "stations" throughout the country, will require great care and the supervision of managers who possess a competent knowledge both of "practice and science."

H. E.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

LONDON.—In accordance with resolutions passed at the extraordinary meeting of the Convocation of the University of London held on July 28 last, an adjourned extraordinary meeting of the House was held on Tuesday week in the University Building, Burlington Gardens, which was very numerously attended. The Chairman of Convocation (Mr. F. J. Wood, LL.D.) presided, and in his opening address explained his ruling that under the said resolutions the business pending before the former meeting might now be proceeded with, and invited the House to resume the debate accordingly. At the time of the adjournment the House had a motion before it, made by Lord Justice Fry, for the reception and adoption of the report of the special committee appointed to consider the project of the "Association for Promoting a Teaching University for London." To this motion an amendment had been moved by Mr. J. W. Bone, seconded by Mr. Philip Magnus, omitting all the words in the original motion after the word "received." At Tuesday's meeting leave was given to Lord Justice Fry to accept the amendment, which thus became a substantive motion, to which his Lordship, however, immediately proposed to add "And that the House now consider what amendments, if any, ought to be made in the said scheme, and that such amendments, if any, be by way of instruction to a committee of revision." For Lord Justice Fry's motion 76 only voted against 122 who negatived it. Ultimately after a three hours' sitting the debate was adjourned to Tuesday, December 8.

ALDERMAN SIR R. N. FOWLER, BART., M.P., has consented to present the City and Guilds of London Institute's Scholarships, Prizes, and Certificates at a meeting to be held on Wednesday evening, December 9, at the Salters' Hall, St. Swithin's Lane, E.C. The Right Hon. the Lord Mayor will preside.

SCIENTIFIC SERIALS

Mittheilungen der Naturforschenden Gesellschaft in Bern, Nos. 1064 to 1091, 1883-4 (three parts).—Contributions to the doctrine of metal-poisoning, by J. Marti.—Terrestrial and fresh-water mollusca collected in the neighbourhood of Berne and Onterlacken, by G. Regelsperger.—An automatically-acting thermograph, by G. Hasler.—Influence of sexual excitation on the composition of cow's milk, by F. Schaffer.—Further paper on the animal world in the pile-dwellings of the Lake of Bienne, by Th. Studer.—On a parasite in the intestine of the horse, by M. Flesch.—On the nature of odorous matters and the causes of smell, by A. Valentin.—Mathematical considerations on the structure of bees' cells, by A. Jonquière.—On the inhibitory mechanism of the heart, by A. Glause.—On the separation of manganese and nickel by means of ozone, by V. Schwarzenbach.—On determinate integrals, by J. H. Graf.

SOCIETIES AND ACADEMIES

London

Zoological Society, November 3.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. Sclater exhibited the skull of a Tapir received by the Society in May, 1878, which was then described as *Tapirus roulini*, but which had since been found, upon anatomical examination, to be merely a dark variety of *Tapirus americanus*.—A letter was read from Mr. J. Caldwell, C.M.Z.S., of Port Louis, Mauritius, announcing the finding of a new deposit of dodo-bones in a small cavern in the south-west part of the island.—An extract was read from a letter addressed to the Secretary by Dr. F. H. Bauer, C.M.Z.S., of Buitenzorg, Java, containing some notes on the Flying Lizard (*Ptychozoon homalocephalum*) of that island.—Prof. Bell exhibited and made remarks on a fine specimen of the Decapod Crustacean, *Alpheus megacheles*, obtained by Mr. Spencer at Herm, Channel Islands.—Mr. Martin Jacoby communicated the second portion of his paper on the Phytophagous Coleoptera of Japan obtained by Mr. George Lewis during his second journey, 1880–81. The present part treated of the Halticinæ and Galerucinæ of Mr. Lewis's collection.—Mr. A. G. Butler read a paper containing an account of two collections of Lepidotera recently received from Somali Land. Mr. Butler considered that the Lepidopterous fauna of Somali Land was essentially Arabian in character.—Mr. L. R. Lydekker, F.Z.S., described a last upper molar of a Mastodon, which had been obtained by Mr. A. H. Everett, C.M.Z.S., in Borneo, and referred it to a small race of *M. latidens*, previously known only from the Pliocene Siwaliks of India and Burmah. The specimen was of much interest, as increasing our knowledge of the eastern range of the Siwalik mammals.—Mr. W. T. Blanford, F.R.S., read a monograph of the genus *Paradoxurus*. After a critical examination of a large series of specimens Mr. Blanford came to the conclusion that it would be necessary to reduce the numerous so-called species of this genus to about ten well-marked forms.—Mr. W. T. Blanford, on behalf of Mr. J. A. Murray, read a paper containing the description of a new species of *Mus* from Sind, proposed to be called *Mus gleadowi*.—Mr. F. E. Beddard, F.Z.S., read an account of the specific characters and structure of some New Zealand earthworms of the genus *Acanthodrilus*.

Paris

Academy of Sciences, November 2.—M. Bouley, President, in the chair.—The Perpetual Secretary announced the death of M. Joly, Corresponding Member of the Section for Anatomy and Zoology, who died at Toulouse on October 17, 1885.—Remarks on the subject of M. Hirn's recent experiments on the velocity of gases with a view to testing the truth of the kinetic theory of gases, by M. Faye. The author infers from the results of these experiments that the kinetic hypothesis will have to be reconsidered, if not absolutely rejected. The limit which it imposes on the velocity of gases under certain conditions of temperature and pressure is shown to be imaginary.—Fresh researches on the origin of the glandular nervous fibres and of the vaso-dilator nervous fibres which form part of the chord of the tympanum and of the glosso-pharyngian nerve, by M. Vulpian.—Remarks on M. H. Filhol's new work entitled "Recherches zoologiques, botaniques, et géologiques faites à l'île de Campbell et en Nouvelle-Zelande," by M. Alph. Milne-Edwards. The researches embodied in this work tend to show that since the Chalk or beginning of the Tertiary epoch Campbell Island can have formed no part of New Zealand or of any other Australasian region.—Solution of a question of indeterminate analysis constituting a fundamental principle in the theory of the Cremona transformations, by M. de Jonquières.—Experimental researches on the temperature observed in the mother at the moment of delivery and of the child at birth: comparison of these two temperatures, by M. Bonnal.—On the attenuation of the virus of ovine variola, by M. P. Pourquier. From his researches, continued for a period of seven or eight years on the principles established by M. Pasteur, the author concludes that it is possible to attenuate this virus, to transform it into a true vaccine, and thus avoid the serious losse hitherto incurred by inoculating sheep against the disease.—On the Cremona transformations in a plane of n order, by M. G. B. Guccia.—On the decomposition of quadratic forms, by M. Benoit.—Note on the theory of M. Helmholtz respecting the preservation of solar heat, by M. Ph. Gilbert.—Note on the doubly-refracted dispersion of quartz, by M. J. Macé de Lépinay.—On the theoric distribution of heat over the surface of the globe, by M. A. Angot.—Combination of the nitrate of silver with the alkaline nitrates (nitrates of potassa, rubidium, ammoniac, soda, and lithine), by M. A. Ditté.—On the anhydrous chloride and silicate of cerium, by M. P. Didier. Having already determined the action of hydrosulphuric acid on the anhydrous chloride of cerium, the author now communicates a process for preparing this substance, and describes some other compounds obtained by its means by the dry process.—Note on the Asteriadæ collected during the *Talisman* expedition, by M. Edm. Perrier. As many as fifty-four species, represented by nearly 200 specimens, were obtained on this occasion, some fished up from depths exceeding 4000 metres.—On the respiration of leaves in the dark: carbonic acid retained by them, second note, by MM. Dehérain and Maquenne.—Note on artificial earthy specular iron, by M. Stan. Meunier.—On the zymotic properties of charbon and septicemic blood, by M. A. Sanson.—On the transmission of virulent glanders to the pig, by MM. Cadéac and Malet.—Treatment of mildew in the vine by means of the sulphate of copper, by M. A. Müntz.—The sulphate of lye-ashes and its employment against animal and vegetable parasitic diseases, by M. Duponchel.—Account of a remarkable meteoric phenomenon observed at Pondicherry on June 13, 1885, by M. C. André.

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THURSDAY, NOVEMBER 19, 1885

LOOMIS'S "CONTRIBUTIONS TO METEOROLOGY"

Contributions to Meteorology. By Elias Loomis, LL.D., Professor of Natural Philosophy and Astronomy in Yale College, &c. Revised Edition. (New Haven, Conn., U.S., 1885.)

IT is now fifty years since Prof. Loomis's attention was directed to the study of meteorology, his interest in the subject having been awakened by Redfield's investigations respecting the phenomena and laws of storms. During the first forty years his principal writings were elaborate discussions of the great storm which occurred in America in December 1836, and an equally remarkable storm which occurred in Europe shortly after the American storm, and an account of another United States storm in February 1842, which in a part of its course was accompanied by a tornado of unusual violence. The chief outcome of these investigations was a new method of charting observations, now so familiar to all the world in our weather maps, and the demonstration of the capital fact in meteorology, that in storms the movement of the wind is spirally inwards, circulating from right to left about the centre of the cyclone.

The generally imperfect character of the barometric observations for a long time precluded all attempts at any satisfactory investigation of the storms and weather of the United States; and it was not till 1871, when the Signal Service was organised, with its uniform methods of observation and reliable barometers, that the data required for the investigation was supplied. When two years' observations had accumulated, Prof. Loomis resumed his inquiries, and from July 1874 a series of papers by him, entitled "Contributions to Meteorology" have appeared from time to time in the *American Journal of Science*. A large number of these we have noticed in NATURE as they appeared. As the subjects investigated were taken up without any regard to systematic order, and as a change of views has necessarily come about as the investigations proceeded, Prof. Loomis has wisely resolved to reduce them to a more systematic form and incorporate into the revised work the results of observations now available, not only from the United States, but also from Europe and other parts of the world. The present pamphlet contains the first chapter of this revision, and the subject dealt with is the areas of low atmospheric pressure, their form and magnitude, and the direction and velocity of their movements.

As regards the forms of areas of low pressures, or cyclones as they are conveniently termed, the greatest and least diameters of all the cyclones represented on the Weather Maps of the Signal Service during a period of three years were actually measured, with the result that the average ratio of the longest diameter to the shortest was 1·94. In 53 per cent. of the whole number of cases the ratio was 1·5; in 33 per cent. 2; in 11 per cent. 3; and in 3 per cent. 4. Similarly the Atlantic storms, as delineated on Hoffmeyer's charts for a period of three years, have been examined, and the measurements show that the ratio of the longest diameter of the cyclones to the shortest is 1·70; and that while in 54 per cent. of the whole number of cases the ratio was 1·5, in 17 per cent. it was 2, and in 1 per cent. 3—thus showing a marked deficiency of very elongated low pressure areas over the Atlantic Ocean as compared with the United States.

Observations show that the longest diameter of cyclones may be turned in any azimuth. In the States it is most frequently directed towards a point somewhat East of North, the point towards which the longest diameter is most frequently directed being N. 36° E. The average direction is sensibly the same for the cyclones of the Mississippi Valley and for those of the Atlantic coast. Over the Atlantic Ocean the direction of the longest diameters are more equally distributed in azimuth than they are in the United States, but the point towards which the longest diameter is most frequently directed is N. 35° E., which corresponds almost exactly with the direction found for the United States.

The cyclones of the tropics frequently exhibit a violence greater than is ever known in the storms of the middle latitudes, but their geographical extent is comparatively small. The inclination of the winds inwards upon the centre is shown to be more strongly marked in tropical cyclones than in most storms of the middle latitudes. From an examination of the weather maps of the Signal Service it is found that in the United States a low pressure area, with only one system of cyclonic winds, frequently has a diameter of 1600 English miles, and Hoffmeyer's charts show that cyclones over the Atlantic have frequently diameters of 2000 English miles. Widespread areas of low barometer, having several centres of cyclonic action, may have a diameter of 6000 English miles or may even form a belt extending nearly, if not entirely, round the globe between the parallels of 40° and 50° N. lat. On the other hand, tropical cyclones are often only 500 miles in diameter, and are occasionally of still less dimensions.

When low pressure areas are very much elongated, two or three cyclonic centres are frequently included within the same area of low pressure. Though these cyclonic centres are occasionally of equal depth, yet they are more generally of very unequal depth and intensity. The weather charts of the morning of March 9, 1876, showed a very large area of low pressure overspreading Europe and the Atlantic Ocean, having a principal centre of low pressure in the north of Scotland, around which violent winds prevailed, rising to 12 on Beaufort's scale, with very steep gradients on the western side of the cyclone. About the same time, and within the same widespread low pressure area, there were four other cyclones, with their centres at St. Petersburg, South Russia, south coasts of the Black Sea, and over the Caspian Sea, respectively.

As an illustration of one of the more extensive areas of low pressure, Prof. Loomis adduces the great barometric depression of June 7, 1882, as shown on the International Weather Map of the Signal Service of that day. This area of low pressure covered the whole of Asia, apparently extending from the equator to a considerable distance beyond the North Pole; it covered the whole of Europe with the exception of a small portion of its southern margin, and also the northern part of the Atlantic Ocean and stretched across the central portion of North America to the Pacific Ocean: thus extending through 320 degrees of longitude. The principal low centre, 29·200 inches, was north of the Caspian Sea; a second low centre, 29·400 inches, was over the northern part of India; a third low centre, 29·600 inches, over the Gulf of St. Lawrence; a fourth low centre, 29·800 inches, over China; a fifth low centre, 29·800 inches, north-east of Japan; and if every part of this large portion of the earth's surface had been sufficiently represented by observing stations several other subordinate low centres would doubtless have been exhibited. On the other hand, a centre of high pressure, 30·400 inches, was found over the Atlantic Ocean; a second, 30·200 inches, over the south-eastern part of the United States; and a third, over the eastern part of the Pacific near latitude 30° N. The area of high pressure formed a belt closely following the parallels of 30°—35° and extending through at least 240 degrees of longitude, but interrupted by the Asiatic Continent.

We drew attention five years ago to the all-important bearings of these areas of high and low pressure on the weather in all the regions of the globe over which anomalously high and low barometers at any time prevail (NATURE, vols. xxi., xxii. and xxiii.). But the importance of this department of meteorology is much enhanced when it is considered that it is through a careful record of the appearance and disappearance in different regions of the globe of these cyclonic and anti-cyclonic areas and an investigation of the causes determining their form, position, and intensity from time to time that we may hope to reach the solution of the problem of the weather. In prosecuting this large inquiry, the results of Prof. Loomis's careful measurements of meteorological phenomena, as detailed in the revised edition of his "Contributions" now before us, form one of the best guides we at present possess.

Direction of Movement of Areas of Low Pressure.—Areas of low pressure, or cyclones, seldom remain stationary in the same position for many hours. The centre of low pressure generally changes its position steadily from hour to hour, and everywhere there is observed a marked uniformity in the direction of this movement. Prof. Loomis gives several charts showing the progressive movement of cyclones in different parts of the world, including one showing nearly all the different storm tracts delineated on the International Weather Maps of the United States Signal Service for a period of more than four years. Maury's Storm Charts are also brought under review. The lowest latitude reached by the centre of any cyclone, which has been distinctly traced, is 6° 1′ N., and there are only eight cases of cyclones whose paths have been traced to points south of lat. 10° N.

Observations indicate that, both in the Pacific and Atlantic, gales are of extremely rare occurrence within six degrees of the equator, and, when they do occur, the barometric depression is small, and the cyclonic character of the winds indistinctly marked. But in low latitudes, a little higher than six degrees, gales are more frequent over the Pacific than over the Atlantic Ocean.

Tropical storms which are found to pursue a westerly course are limited to two regions of the globe—viz. the Atlantic Ocean, but particularly its western portion, near the West India Islands, and the region south of the continent of Asia. As regards the Pacific, no cyclone has ever been observed, except near Asia or its outlying islands.

As regards the tracks of tropical cyclones in the neighbourhood of the West Indies, the teaching of the data represented on the International Charts is that nearly all the areas of low barometer which occur within the tropics and advance westwards, instead of following the ordinary course of the trade winds, advance in a direction somewhat north of west. Of these West Indian cyclones, 88 per cent occurred in August, September, and October, thus leaving only 12 per cent. for the other nine months of the year. On the other hand, of the Asiatic cyclones 52 per cent. occurred in September, October, and November, and 43 per cent. in April, May, and June, thus leaving only 5 per cent. for the other six months. There is, therefore, a marked seasonal difference as to the frequency of the tropical cyclones of the Atlantic as compared with the Pacific: in the Atlantic they are almost exclusively confined to the autumn, but in the Pacific they are nearly as frequent in spring as in autumn.

The average direction of the course of the Asiatic cyclones, while moving westward, is 38° north of west, which closely accords with that found for West Indian cyclones. But, as regards the onward progress of tropical cyclones, whilst Asiatic cyclones advance westwards at the average rate of 8 English miles per hour, the average velocity of West Indian cyclones is double that amount. Asiatic cyclones come around to a due north course about lat. 19°·8 N., but West Indian cyclones do not assume a due northerly course till, on the average of instances, lat. 30° N. is reached. In the Pacific the average course of cyclones, after turning eastward, was 35° E. of N., and their velocity was 9·8 miles, which is scarcely half of the velocity of the West Indian cyclones. These striking and vital differences between the tropical cyclones of the Atlantic and the Pacific will doubtless play no unimportant part in the development of the theory of the cyclone.

An examination of Prof. Loomis's chart of storm-tracks for the northern hemisphere, with wind charts indicating the prevailing direction of the wind, shows a remarkable correspondence between the two classes of facts. Examining the point more narrowly, Prof. Loomis finds that for the middle region of the Atlantic, near lat. 50°, the average direction of storm paths corresponds very closely with that of the average direction of the wind; but in the western part of the Atlantic the average course of storms is considerably more northerly than that of the wind, while in the eastern part it is more southerly. These results, which fairly accord with those derived from tropical storms, seem to indicate, in the opinion of the author, that in the middle latitudes of the northern hemisphere the direction of progress of storm-centres is not the same as that of the average wind, but is sensibly affected by some other causes; and that the results derived from observations in the China Sea indicate that one of the causes is the prevalent direction of the wind which immediately follows a storm. The subject is further prosecuted by an examination of the prevailing winds and storm-tracks during the three winter months for the ten winters ending 1882 of that portion of the United States between long. 90° W. and the Rocky Mountains. The result of this somewhat exhaustive comparison is similar to that derived from the observations on the Atlantic—there being observed no rigorous correspondence between the average direction of the movement of storm-centres and the prevailing wind; but that in some regions the average course of storm-centres is more northerly than that of the wind, and in some regions more southerly.

While in middle latitudes the generally progressive movement of cyclones is in an easterly direction, cyclonic areas are occasionally observed, both in Europe and America, advancing to westward. After a careful investigation of forty-one of the most decided cases which have occurred of these westerly movements of cyclones, it is considered that the following conclusions are warranted—viz. that the westerly movement of low-pressure centres is due to a fall of rain or snow, in most cases unusually great, in the region towards which the low centre advances; and the influence of one low-pressure area acting apparently as an attractive force upon another adjacent low-pressure area; to the influence exerted by two areas of high pressure, not far apart, by which a new movement is imparted to the air included between them, a new low centre being sometimes developed; or to the influence of a high pressure on the north-east side of a low-pressure area, when the gradients on the south-west side of the low area are slight, in which case the centre of the low-pressure area may be crowded towards the south-west.

Rate of Progress of Cyclones.—The rate of progress of the United States storms for thirteen years has been calculated, and the results arranged according to the months, and expressed in miles per hour. The average rate of progress for the year is 28·4 miles, rising to the maximum, 34·2 miles in February, and falling to the minimum, 22·6 miles, in August. As regards different years, the variation is also much greater in the winter than in the summer months. Thus, in November, 1878, the rate was 21·2 miles per hour, but in the same month of the following year it was 40·7 miles; and, on the other hand, in July, 1882, the rate was 19·8 miles, but in July, 1881, it was 26·6 miles—the difference between the extremes of November being thus 19·5 miles, and in July only 6·8 miles.

In Europe during the five years ending 1880 the mean annual rate of progress was 16·7 miles, rising to the maximum, 19·0 miles, in October, and falling to the minimum, 14·0 miles, in August. Hence the onward movement of storms in the United States is two-thirds greater than in Europe, the rate of excess for the United States over Europe being 1·9 in winter, and 1·5 in summer. On the mean of the year the average onward movement of storms is, in miles per hour, 28·4 for the United States, 18·0 for the middle latitudes of the Atlantic, 16·7 for Europe, 14·7 for the West Indies, and 8·5 for the Bay of Bengal and the China Sea.

Prof. Loomis is led to conclude that the general system of atmospheric circulation, consisting of the trades of equatorial regions and the westerly winds of the middle latitudes, is the primary cause which determines both the direction and velocity of the movement of storm centres; but as respects each individual storm, the determining cause is not so much the average system of atmospheric circulation, as the general movement of the atmosphere going on at the time, and in the vicinity of that particular storm. The influence of this general movement is, moreover, materially modified by a variety of causes, among which may be enumerated the rainfall, and the position of the region over which it falls with respect to the centre of the storm; the size and position of neighbouring areas of high and low pressure, the distribution of temperature, and the physical configuration and character of the surface.

In further prosecuting this important discussion, the time has perhaps now come for meteorologists to give more consideration and weight to the physical conditions of the cyclone, more particularly to the method of distribution of temperature and aqueous vapour within and in the more immediate neighbourhood of the cyclone. This point, which was so strongly dwelt on and urged by Dove, has for some time past been allowed to fall too much into the background. A cyclone is not merely a system of low pressure with winds all around blowing vorticosely inwards upon the centre; but it is further distinguished by this, that the atmosphere in front of its path is relatively warm and moist, and in the rear cold and dry. These features are seldom kept so steadily in view by meteorologists as they ought to be in the discussion of such questions as Prof. Loomis has here brought under review.

One outstanding difference of the storms of America and those of Europe is that nearly all of the American storms originate on the continent, not far from the Rocky Mountains, whereas the storms of Europe originate mostly on the ocean. It is not improbable that more than one of the important points of difference between these two classes of storms shown by Prof. Loomis have their explanation in the different conditions under which they have their origin.

OUR BOOK SHELF

A Treatise on the Calculus of Variations. By L. B. Carll, A.M. (London: Macmillan, 1885.)

A Text-Book on the Method of Least Squares. By Mansfield Merriman. (London: Macmillan, 1885.)

Both these works by American mathematicians have been, we believe, printed in America, and are now introduced to the attention of English students by Messrs. Macmillan. They are first-class representatives of the good work now being done in this field: we have (Nature, vol. xvi. p. 21, vol. xxvi. p. 59) already given account of other American mathematical publications.

Mr. Carll, on his title page, states that his treatise is "arranged with the purpose of introducing, as well as illustrating, its principles to the reader by means of problems, and designed to present in all important particulars, a complete view of the present state of the science." The subject is one which certainly has not engaged the time of our book-compilers, for which good and sufficient reasons might be assigned. In 1810, as Todhunter writes, a work was published by Woodhouse, which has obtained a high reputation for accuracy and clearness. That work was not followed by any systematic treatise in English until the year 1850, when Mr. Jellett brought out his valuable "Elementary Treatise on the Calculus of Variations," an octavo volume of 377 pages, with an introduction of 20 pages. In the later editions of Mr. Todhunter's integral calculus are given such portions of the subject as are generally read by students. The same writer's "History" and "Researches" should be in the hands of all who desire to get up this branch thoroughly. After the lapse of so long an interval as thirty-five years we are not surprised to find that Jellett's work is difficult of access to general readers, and on this ground, if on no other, we welcome the present attempt to bring the "Calculus" to the fore again. The author follows Airy and Todhunter in the view he takes of a variation, and Jellett and Strauch in the treatment of varying functions, but he has not neglected to give fairly full accounts of the conceptions and methods of other writers.

A good deal of the preface is taken up with details which might well be omitted should the work reach a second edition, as we hope it may.

There are in all five chapters (568 and xvii. pages) printed in good type and in excellent style.

Chapter i., maxima and minima of single integrals, involving one dependent variable is broken up into ten sections: Chapter ii., maxima and minima of single integrals involving two or more dependent variables in two sections: Chapter iii., maxima and minima of multiple integrals in six sections. Chapter iv., applications to determining the conditions which will render a function integral one or more times in two sections.

Chapter v. gives a historical sketch of the rise and progress of the calculus of variations founded upon Todhunter's "History," and closes with an account of the "Researches in the Calculus of Variations," referred to above.

We have nothing to say of Mr. Merriman's work in addition to what we have said already (NATURE, vol. xxx. p. 334): the works are identical, except in the title pages.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Italian Aid to Biological Research

THE Committee appointed by the Royal Academy of the Lincei in Rome at the request of H.E. the Minister of Naval Affairs, to see that the best possible use in the interests of science be made of the natural history specimens collected by officers of the Royal Italian Navy, wishes to make known to all students of biology that rich material for study, consisting of a certain number of plants and extensive collections of animals of nearly all classes, is at present deposited at the Zoological Station at Naples. This material has all been collected by the officers of the Royal Navy, principally by the *Vittor Pisani* in a recent voyage round the world, and by other Italian men-of-war in the Red Sea and the Ægean Sea. These collections have been preserved by the best and most modern methods, and can be used for histological and morphological researches, in accordance with the actual requirements of science, as well as for systematic and faunistic investigations. The Committee places this rich material at the disposal of the men of science of all countries who will ask to take part in its illustration, either to complete monographs in course, or for monographical works or for special research on any organic system of a given group.

The requests, on which the Committee will decide, are to be sent to Prof. Trinchese, University of Naples.

Prof. TRINCHESE, Naples
Prof. TODARO, Rome
Prof. PASSERINI, Parma
Prof. GIGLIOLI, Florence
Lieutenant CHIERCHIA (Royal Italian Navy), Naples
Prof. DOHRN, Naples

The Resting Position of Oysters

IN a letter from Mr. J. T. Cunningham in your impression of NATURE of October 22 (p. 597) it is sought to show that the oyster does not rest on its left but on its right valve. The evidence which appears to him conclusive on this question is "that the right flat valve is always quite clean, while the convex valve is covered with worm-tubes (*Stylea grossularia*) and Hydroids."

This observation is correct on the whole, but not decisive for the question under consideration. After reading Mr. Cunningham's letter I proceeded to examine 140 oysters in my collection of Schleswig oysters, and found only on a few right valves a worm (*Pomatoceros tricuspis*) or a Cirripede (*Balanus crenatus*), whereas on many *left* valves I distinguished sponges (*Halichondria panicea*), *Alcyonium digitatum*, Hydroids (*Sertularia argentea, Tubularia indivisa, Eadendrium rameum*), Bryozoa (*Alcyonidium gelatinosum*), *Balanus crenatus, Pomatoceros tricuspis*, or *Sabellaria anglica*. Of the 140 oysters examined 43 still bore on their shells the body on which as spawn they had reared themselves, namely pieces of oyster-shells, *Mytilus edulis, Mya arenaria, Mya truncata, Cardium edule*, or *Buccinum undatum*. All these adherent bodies were attached to the nucleus of the left valve, not one single piece to the nucleus of the right. And this is a circumstance decisive in the question raised by Mr. Cunningham. The places on the right valve, where living animals rest, did not stick close to fixed bodies, but the water flowed freely over them, thus admitting embryos to settle on them. The bottom of oyster banks is not a smooth surface, but is formed mainly of old oyster-shells on which many living oysters do not assuredly plant themselves closely and horizontally, but lie often obliquely. It is thus that Hydroids, Sponges, Alcyonium, and Alcyonidium, having settled on the right lower valve, are enabled to grow freely in the water and without let or hindrance develop to the length of four or five inches.

Kiel, October 31 KARL MÖBIUS

Universal Secular Weather Periods

I DO not want to pose as a statistical cycle-hunter, or to bolster up any mere apparent local periodicity of a certain meteorological element, but I wish to place before your readers the appended independent paragraphs from two journals, one on each side of the Atlantic, and to ask any unprejudiced person if we have not here some preliminary evidence (all the more valuable from its being so evidently incidental and unconscious) in favour of the march of certain secular weather areas, possibly connected with barometric waves, similar to those traced out by Messrs. Chambers and Pearson in India, across the Atlantic, from America to Europe.

I would not submit such slender evidence to criticism were it not that it concurs entirely with certain views put forward by myself in a recent paper in the Royal Meteorological Society's *Quarterly Journal*, on "The Height of the Neutral Plane of Pressure in India," and that I have long felt that the entire question demands attention both on scientific and economical grounds. Also both paragraphs include last year, thus bringing the apparent periodicity up to date.

Being at present fully engaged in two other branches of research, I am unable just now to take up this hopeful and important problem, but I would suggest that if we ever intend to forecast the *general character* of the weather of a season or year, which even in this country undergoes long periodic changes, during which it remains for weeks and months together of the same *type*, some such method as the following must be adopted:—

Annual and seasonal mean barometric charts must be constructed from records at principal stations in America, Europe, and Asia for the past fifty or sixty years, and from them barometric abnormals for each year, and for each season, must be calculated, and charted. An examination of these ought to throw great light on, if not to some extent solve, the question of the motion of the larger pressure areas which in turn guide and control the motion of the smaller diurnal systems. The work would, I admit, be one of some considerable magnitude, but surely it is one imperatively demanded in the interests of the science, besides being *a priori* likely to yield valuable results. It has long been a cherished idea of mine to endeavour to carry out the scheme myself, and it is only because I feel precluded from doing so at present by the pressure of other work that I throw out the suggestion for the benefit of any who feel disposed to take it up.

The paragraphs are as follows :—

Mr. Baldwin Latham, in a discussion which ensued upon the Report of the Committee on Decrease of Water Supply (*Quarterly Journal* Roy. Met. Soc., p. 223), said :—

"The records showed that there appeared to be a recurrence of low water every ten years. There was lower water in 1824 and in 1835; the period 1844–5 was low, especially when compared with the years immediately before and following; 1854 was remarkably low; also 1864–5, 1874–5, and now they come to the present low period of 1884–5.

"As to what was the cause of this marked periodicity it was very desirable to ascertain, and, having pointed it out, probably some light might be thrown on the subject."

The other is from the *American Meteorological Journal* under the heading "Cold Winters in Michigan," and the writer says :—

"It is interesting in this connection to notice that the local reports of extremely cold winters place them at intervals of between ten and eleven years. . . . The winter of 1842–3 is thus shown to have been extremely cold; also the winter of 1853–4; the winter of 1863–4 noted for its terribly cold new year; the winter of 1874–5, when the frost penetrated into the ground in Port Huron four to six feet, there being scarcely a thaw between January 1 and the middle of March; and, lastly, the winter of 1884–5, which beats the record for extreme cold during January and February."

I may add that before I had seen either of these paragraphs I had concluded from other sources that the years 1821–2–3–4, 1833–4, 1844–5, 1866–7, and 1875–7 were characterised by mild winters in Europe and unusual cold in Iceland and America, being preceded in most cases by drought during the summers; but of course this represents merely the result of a preliminary glance at some general records of noteworthy seasons.

November 9 E. DOUGLAS ARCHIBALD

Photography of the Corona

I HAVE been following with interest the communications which have been made from time to time to *Science* by Mr. W. H. Pickering regarding the photography of the corona in full sunshine. Whilst admiring the manner in which he has built up his theoretical objections to its possibility, I am forced to dissent from his deduction from the fact that the theory does not fit in with the results actually obtained during the eclipses observed in Egypt and the Caroline Islands. I have in my hands at present spectrum and other photographs of the corona made during the expeditions to those localities, and from them I gather he has evidently much underestimated the photographic brightness of the corona as compared with that of the sky. As I propose shortly to read a paper before the Royal Society on the subject, I cannot enter into details at the present moment. All I will say is that the comparative photographic intensity of both can be estimated with approximate exactness from the data I have by me.

I write this for insertion in your columns, as in your last issue you have a note regarding Mr. W. H. Pickering's communications on this subject. W. DE W. ABNEY

Permanence of Continents and Oceans

MANY naturalists are accustomed, in lecturing, to speak of the existing ocean basins as "permanent." Though this must to a large extent be a true statement, many geologists at all events must be perfectly aware that the former distribution of life requires that nearly all lands, however remote at present, must have been, perhaps more than once, in connection with each other. Tropical South America is perhaps the most isolated continental province now existing. I would ask these naturalists to explain how its species of tropical genera not peculiar to it got there, and how many of them came to be represented in Europe in Tertiary times.

That the lands are always chiefly centred about the same spots, and also the converse, would, I think, be an acceptable way of putting it; but that the Atlantic was never bridged except towards the Arctic and Antarctic circles, is a statement that is unwarrantable because contradicted by unimpeachable evidence. J. STARKIE GARDNER

History of Elasticity

IN order to estimate Poncelet's services to the theory of elasticity I am extremely desirous of examining certain works by him. These works are not to be found in the London or Cambridge Libraries, and the Paris booksellers to whom I have applied despair of being able to procure copies. It will hardly be possible for me to go to Metz to examine them before the publication of the first volume of the "History of the Mathematical Theories of Elasticity." Possibly some of your readers may know of the existence of accessible copies in this country. If so, I should esteem it a great favour if they would communicate with me at University College.

In 1827–29 Poncelet gave at Metz a "Cours de Mécanique Industrielle aux Artistes et Ouvriers Messins." In this "Cours" various important points of theoretical elasticity were considered for the first time.

It was published as follows :—

(*a*) Part I. Lithographed edition, Metz, 1827.

(*b*) Part II. First edition lithographed 1828; second edition lithographed 1831.

(*c*) Part III. Lithographed edition, 1831.

(*d*) Part I. First printed edition, Metz, 1829; second printed edition, Metz, 1831.

It is needful to remind your readers that there are numerous other works entitled "Mécanique Industrielle," by Poncelet, published at Liége, Paris, and Brussels, differing from each other, and entirely from the above. These I have examined, but they do not contain what I require. KARL PEARSON

University College, London, November 15

The Heights of Clouds

In the very favourable notice of our "Mesures des Hauteurs et des Mouvements des Nuages," in NATURE of October 29 (p. 630), there exists a misunderstanding as to the probable errors of our measurements, which makes our observations seem much more inexact than they really are. I therefore ask your permission to correct it.

Mr. W. de W. A. says: "Perhaps one of the most easily-observed clouds is the cumulus, and we find from a table given that the *probable error of observation* is very considerable." But, in fact, what is there referred to as an error of observation is not such an error; it is the probable uncertainty ("incertitude probable") *depending on the variability of the phenomenon itself.*[1] This is expressly stated in the treatise. On p. 39 (that following the table quoted) there may be read: "L'incertitude calculée comprend ainsi et celle dépendant de la variation des hauteurs des nuages, et celle provenant des erreurs d'observation. Celle-ci est cependant assez petite par rapport à la première et à peu près constante pour les différentes heures du jour, comme on le trouvera en la calculant séparément à l'aide des erreurs moyennes *m*." That mean error *m* is just the *mean error of observation* in the height of a cloud, and in our "list of observations" we have given it for every observation, as well as the corresponding mean angular error of the observation. By calculating the probable error of an observation of cumulus by means of those values of mean errors we have found it to be 35 *metres* (instead of 748 metres, as Mr. W. de W. A. thinks it to be), and the probable error of the mean is found to be 3 metres (instead of 40 metres), the whole number of observations being 134.[2]

Thus the above assertion is fully justified, viz. that the errors of observation may be quite neglected when compared with the uncertainty depending upon the variability of the heights of the cumuli from one cloud to another. That variability is itself a phenomenon worthy of investigation, varying as it does according to the hour of the day and the barometrical state of the weather, and that is the reason for which we have calculated it. As to the mean angular error in observing a cloud, we have found it very often to be inferior to that obtained in observing the centre of the sun, and in all the better observations that error is fully comparable to the error in observing the sun, as may be seen from our treatise. This proves that, for such observations, the uncertainty of an identical point of cloud did not exist at all, the whole uncertainty depending on the unavoidable instrumental errors. Still it may be that the errors are

[1] For the figures in the table quoted represent simply the *probable difference* of an observation (of the mean found) from the *true* mean calculated by the method of least squares.

[2] For the higher clouds, as the pure cirri, this error was often very great indeed, but it was so because their distance was much too great when compared with our basis, the parallax obtained being not greater than 1° or 2°. This year (1885) the measurements are regularly pursued from the ends of a basis of 1302 metres, and we can now determine with great accuracy the height even of the most elevated cirri, as well as their horizontal and vertical velocities.

somewhat less in using a photographic theodolite than in using our instruments. But on the other hand our method enables us to observe the clouds even in twilight and moonlight, in rain and storm. Also, it is, no doubt, much cheaper than the photographic one. N. EKHOLM

Upsala, November 6

The Helm Wind

SOME years ago I passed a summer at Melmerby, which is about the best place for seeing the "helm," which is incorrectly described as affecting the Penrith valley (for, in fact, it never extends to Penrith) by your correspondent, M. Woeikoff.

Melmerby is at the foot of the Cross Fell range, and gets the "helm" with great violence. When an easterly wind comes on, the summit of Cross Fell becomes clouded; *it puts on its helm:* then from this a violent cold wind pours down the hillside (which is steep) and rises up again at no great distance. At Melmerby, and places similarly situated, there is clear sky, for the moisture in the sky is invisible, but further from the range it is precipitated where the current rises, and there is cloudy sky, without the strong wind. The phenomenon is, in fact, precisely that at Table Mountain, where the cloud on the crest is called the "table-cloth."

Judging from M. Woeikoff's description there seems to be a difference in the phenomena. Probably owing to the *gentle slopes* of the Varada chain the air does not seem to *rise again*, and there is no cloud-bank parallel to the chain. It would seem, too, that the wind extends to the *west*, unless there is a misprint. J. F. TENNANT

37, Hamilton Road, Ealing, W., November 13

THE MODE OF ADMISSION INTO THE ROYAL SOCIETY

OUR contemporary *Science*, in the last number which has reached this country, makes some remarks concerning the admission of candidates into the Royal Society, against which, in the interests of truth and accuracy, it is our duty to protest, the more especially as it is also implied that the French system of canvassing those who are already Fellows of the Society is also adopted.

The statements actually made are (1) that there is an "actual competitive examination, on the result of which a certain number of successful candidates are annually chosen," and (2) "that the English method has the additional disadvantage that it does not secure the men whom it is most desirable to honour." We read also, "During the schoolboy period the distinction between different individuals is a distinction of learning, and an examination is not unfitted to discover the boy who deserves reward. But learning is not the quality which a State needs to make it great. Casaubons are not the kind of men who have built up English science. The qualities which ought to be encouraged, and which it should be a nation's delight to honour are qualities too subtle to be detected by a competitive examination."

For the benefit of our transatlantic brethren we may as well state the facts as we know them. For reasons into which we need not enter here, as they do not affect the question at issue, nearly forty years ago the Royal Society determined to limit the yearly admissions to fifteen; and to throw upon the Council the responsibility of selecting the fifteen who are to be nominated for election, a general meeting of the Society reserving to itself the right of confirming or rejecting such nomination. It may be instructive to remark that for thirty years that right has not been exercised.

The way in which the matter is worked is as follows:—The friends of a man, who are already in the Society, and who think he is entitled to the coveted distinction, prepare a statement of his services to science, in many cases without consulting him in any way. This paper thus prepared is sent round to other Fellows of the Society, who are acquainted with the work of the candidate, and who sign it as a testimony that they think he is worthy of election. In this way when the proper time arrives some fifty or sixty papers are sent in to the Council for their consideration. In the Council itself we may assume that the selection of the fifteen is made as carefully as possible in view not merely of individual claims but of the due representation of the different branches of science. It is not for us to state the safeguards or mode of procedure adopted, but we think we may say that the slightest action or appeal to any member by the candidate himself would be absolutely fatal to his election. Finally, we may say that, years back, when a heavy entrance fee had to be paid, there were cases in which the question had to be put to one whose friends were anxious to see him elected, whether he would accept election. The small yearly subscription of 3*l.*, now the only sum payable, makes even this question unnecessary at the present time.

ON MEASURING THE VIBRATORY PERIODS OF TUNING-FORKS

THE tuning-fork when its number of double vibrations, to and fro, in a second, or briefly its *frequency*, has been ascertained, is a most convenient instrument for measuring minute divisions of time. As such it is now extensively used for physical, physiological, and military purposes (velocity of bullets and cannon balls). The antecedent difficulty of ascertaining the frequency, is however very great. The old processes, sufficient for roughly ascertaining musical pitch, and depending upon wires of known weight, length, and tension, or the action of the siren, are totally insufficient for modern purposes. It was the contradictory nature of the results furnished by the monochord in the division of the Octave into twelve equal parts that led Scheibler to his system of a series of tuning-forks differing from one another by known numbers of vibrations, leading to countable beats, and extending over an Octave. Nothing can be more convenient to use than such a series of forks for all musical purposes. They enable the frequency not only of any small as well as large tuning-fork, but also of any sustained tone to be ascertained within one-tenth of a vibration, that is, one vibration in ten seconds. The writer has for some years been in the constant habit of using such a set of forks with the most satisfactory results. His own forks were measured by Scheibler's (exhibited in the Historic Loan Collection of Musical Instruments at the Albert Hall this year), but extend over a greater range, from about 224 to about 588 vib., that is, rather more than an Octave and a major Third. The great advantage of such a tonometer is extreme portability, immediate application to any sustained tone (even that of a pianoforte string), and the independence of the result from any (almost always imperfect) estimation of unison by a musical ear. There are of course antecedent difficulties in ascertaining the pitch of each particular fork, but these are overcome by patient observation, the extension of the series beyond an Octave furnishing in itself the required check.

Scheibler died in 1837. In 1879 Prof. Herbert MacLeod and Lieut. R. G. Clarke, R.E. (*Proc. R. Soc.*, vol. xxviii. p. 291, and *Philosoph. Trans.*, vol. clxxi. p. 1) invented an optical arrangement, which under proper management (but the manipulation was very difficult) gave excellent results for large tuning-forks, like those of Koenig. And in 1880 Koenig (*Wiedemann's Annalen*, 1880, pp. 394-417) invented a clock method for ascertaining with extreme accuracy the frequency of one large standard fork of 64 vib. at 20° C. Before both Prof. MacLeod and Dr. Koenig, Prof. Alfred Mayer, of Hoboken, New Jersey, U.S., had invented a most careful and ingenious electrographic method, of which a full account has just appeared in vol. iii. of the *Transactions* of the National Academy of Sciences, U.S.[1] Briefly this last method consists, first, of making the tuning-fork itself, by means of an added style of extreme tenuity, scribe its vibrations as sinuosities in a curve on a revolving cylinder of smoked paper, an old conception; and, secondly, of determining the exact number of such sinuosities as occurred in a second, by means of electricity, which was entirely new, and in which lies the pith and difficulty of the method.

When in 1879 the writer was collecting materials for his "History of Musical Pitch" (*Journ. of Soc. Arts*, March 5 and April 2, 1880, and January 7, 1881), it became necessary to verify Scheibler's forks, and to do so he had five large forks constructed, giving the pitches of certain forks preserved in the Conservatoire at Paris. These forks he measured with great care by Scheibler's tonometer, and then Prof. MacLeod measured them by his process, after which they were sent to America to be measured by Prof. Mayer (the particulars of his measurements of these forks are given in his paper cited above), and on their return they were remeasured by the writer with the scribing-points on, and by Prof. MacLeod with the scribing-points on and off, in order to ascertain the flattening caused by the scribing-points, and also any losses that might have been occasioned by the journey. The sum of the two affected only the second place of decimals, except in one fork, where they amounted to 0·2 vibrations. By adding these, and also correcting for temperature, the result was an agreement of all the three methods within 0·1 vibrations.[2]

But Prof. Mayer's results are given to three places of decimals, which it would be extremely difficult to check, not only because of the delicacy of the measurement, but on account of the alteration of pitch by temperature, and the uncertainty which prevails over the coefficient of alteration. Thus for 1° F. Prof. Mayer considers this coefficient to be ·00004638, or 1 in 21561; Prof. MacLeod takes 1 in 20,490, and Dr. Koenig as 1 in 16,097, or in 16,112, or 16,000. The writer's own experiments, between 59° and 175° F., gave 1 in 18,280. For all ordinary purposes 1 in 20,000 may be conveniently used. But the coefficient certainly alters with the size, shape, and quality of the fork observed, and hence it is necessary to correct each observation for temperature separately, before taking the mean, as Prof. Mayer has done. Under these circumstances, at most 2 places of decimals (perhaps only 1) out of 3 of Prof. Mayer's means can be trusted. That is, it is doubtful whether his process for measuring the frequency of tuning-forks is superior to Scheibler's, properly carried out.

The difficulties of the process, which caused Prof. Mayer much trouble to overcome, may now be referred to. The kernel of the method consists in a very exact assignment of the beginning and end of each second on the sinuous curve of vibrations. This is obtained from a clock, the rate of which has to be ascertained. Its pendulum is armed with a point which cuts through a globule of mercury in a cup, screwed up to be small and rigid, and, as this globule rapidly becomes oxidised, by the passage of electricity, it must be renewed for each experiment. The spark from the inductorium at every contact of the pendulum and mercury, must make a *single* perforation of the smoked paper covering the cylinder. To effect this the strength of the current must be carefully regulated, as otherwise a great number of holes may be made. The paper is very interesting on this point, which is well illustrated by experiments and a diagram. Other precautions are necessary, but the above two are the most important. The primary coil of the inductorium and the clock (through the pendulum and globule of mercury) are placed in the circuit of a voltaic cell. The fork and cylinder (separated from the style by the thickness of the smoked paper) are placed in the secondary circuit of the inductorium. The work of the fork on the paper in scribing was found not to flatten by more than ·004 vib. The flattening from the appended scribing-point was shown by Prof. MacLeod's measurements of the writer's forks to vary from ·021 to ·0475 vib. It therefore always sensibly affected the second place of decimals, showing that the results for determining the frequency of an unarmed fork, when the effect of the arming could not be determined (as it cannot be by Prof. Mayer's method), could not be trusted beyond one decimal place. This limit can be reached very simply without all this apparatus and these precautions, by simply counting the beats of good forks within beating distance of each other. Prof. Mayer's method, therefore, does not surpass Scheibler's for simply determining the frequency of tuning-forks, but is fully equal to it, provided the forks are sufficiently large. Neither Prof. Mayer's nor Prof. MacLeod's process is applicable to small forks. The writer is doubtful whether the passing of a current through one prong of the fork and not the other may not affect the period of the fork. The necessity of screwing the fork on to a block (as indeed of screwing it into a resonance box) is always dangerous from the possibility of twisting the prongs. The writer has known of a fork which was thus considerably altered. The frequency of a fork screwed on to block in this way is not the same as that of a fork on a resonance box. Prof. Mayer has himself, in his paper, determined that the amount of correction for support and scrape may amount to – ·026 vib. Prof. Mayer does not renew the excitation with a bow during the same observation, as Prof. MacLeod had to do, and he has shown that the frequency is practically independent of the amplitude of vibration.

Prof. Mayer did not himself apply his instrument to determine the frequency of forks generally, but, as he states in the title of his paper, specially as a chronoscope. In that case the above difficulties disappear. What is wanted to know is the exact number of vibrations of the scribing-fork as it scribes, affected by all the circumstances mentioned—screwing, scribing, passage of electricity, &c. We are not in the least concerned to discover the frequency of the unscrewed, unarmed, unelectrified fork. Even temperature is of no consequence, provided it be uniform during the experiment. The velocity of rotation of the cylinder is also immaterial, provided it be constant for one double vibration, which can hardly help being the case for such a small fraction of a second. There is only one source of error, the inequality of the seconds' pendulum, arising from the globule of mercury being of a sensible magnitude, so that an appreciable time is occupied in traversing it (eliminated by counting the sinuosities for every two seconds instead of every second), and the inevitable want of true centering of the globule and pendulum (eliminated by taking a mean). Prof. Mayer's arrangement then becomes an extremely simple and also an extremely accurate means of measuring short intervals of time within, to a certainty, one-hundredth of a vibration of the fork. Thus, if the fork gives 400 vibrations in a second, the measurement would be correct to one-forty-thousandth part of a second!

Prof. Mayer concludes his very valuable and interesting paper—which is recommended to the attention of all experimenters requiring accurate chronoscopic observations—with showing the arrangement for experimenting with this chronoscope "on the velocities of fowling-piece shot of various sizes projected with various charges of powder from 12- and 10-gauge guns," with a diagram giving the

[1] "On a method of precisely Measuring the Vibratory Periods of Tuning-Forks, and the determination of the Laws of the Vibrations of Forks; with special reference of these Facts and Laws to the Action of a Simple Chronoscope."

[2] Prof. Mayer measured, at temperatures varying from 63·3 F. to 69·25 F. The standard temperature of the writer was 59° F. = 15° C., the temperature at which the Diapason Normal in Paris has been settled. It may be mentioned that in Prof. Mayer's tables xiii. and xiv. of this paper, the titles have been transposed; the first related to the Tuileries fork, 434 vib., and the second to the Feydeau fork, 422·8 vib., and not conversely as printed.

position of the wires and make-circuit lever, and tables of the results, and says, finally:—

"The simplicity and inexpensiveness of the chronoscope we have described in this paper, its accuracy, and the ease with which it is used, must commend it to all who will give it a trial under the conditions of the action which we have endeavoured to set forth in this paper. Another of its advantages is that its records on the paper covering the cylinder are easily rendered permanent by drawing the unsmoked side of the paper over the surface of a dilute solution of photographic negative varnish contained in a wide shallow dish. On the records may be written with a blunt style the nature of the experiments they record before the carbon is fixed by the varnish, and then they can be bound together in book-form for preservation and reference."

ALEXANDER J. ELLIS

HINTS ON THE CONSTRUCTION AND EQUIPMENT OF OBSERVATORIES FOR AMATEURS

IF it were necessary to offer any apology for the short series of articles of which the first is now presented to the readers of NATURE, it might be found in the fact that, so far as I know, nothing fulfilling the above title has been put into circulation in England for more than forty years. This is the more remarkable when one considers the great development of astronomy in this country during the present generation, a development the credit of which is far more due to amateur effort than to the influence of Governments or public establishments. The reason I have fixed upon the year 1844 is that that was the year in which Admiral Smyth published his well-known "Bedford Catalogue of Celestial Objects," to which he prefixed certain chapters dealing with the construction and management of small observatories.

Those chapters have never been reproduced in any form, partly, no doubt, for the reason that they are a good deal out of date; but they are still capable of furnishing many useful hints to any one who wishes to write on the subject of observatories.

It is not too much to say that the Bedford Observatory has directly or indirectly served as the model for nearly all the private observatories of moderate dimensions since erected in England, and it is equally certain that, whatever may be the changes which considerations of finance, or architecture, or geology, may render expedient in particular instances, no important alterations need be made in the main features of the Bedford Observatory, although upwards of half a century has elapsed since it was erected, and more than forty years have passed away since it was pulled down.

In order to compress as much information as possible into a small compass I propose to classify what I have to say in such a way as shall successively conduct the reader step by step through the stages which he himself will have to pass through between the time when he determines to erect an observatory and the time when he finds himself the happy possessor of the completed building. Of telescopes as such I shall here say nothing, and the only other prefatory remark which seems requisite is this: that an amateur astronomer with only a given and moderate sum of money to lay out will do well to appropriate an adequate part of his funds to the purchase of a fairly good stand and of a suitable structure in which to house his instruments, rather than spend too much on his tube and then be obliged to starve the stand and to put up with inadequate shelter from the weather or no shelter at all. To begin, therefore, at the beginning.

The Choice of a Site.—As to this the amateur will probably in most cases be obliged to suit himself as best he can. If his garden offers any varieties of site, he should endeavour to secure one on slightly rising ground, with an uninterrupted horizon to the south (for meridian purposes) and to the west (for comets and inferior planets in the vicinity of the sun at sunset). A clear horizon to the east is of less moment, unless searches for comets before sunrise are intended to be systematically carried out.

In making preparations for building an astronomical observatory—and occasionally, indeed, for other purposes—it is necessary to know how to set out a meridian line. Of course this may be done by means of a mariner's compass (correcting for the magnetic deviation); but there are other ways of doing this independently of a compass, and as it is not always easy to ascertain the deviation a statement of at any rate one of these other ways, as given by Challis, will be useful. Set up a pole at the spot through which the proposed meridian line is required to pass, using a plumb-line to ensure the pole being vertical. Draw around the pole as a centre several concentric horizontal circles, and mark the points of coincidence of the extremity of the shadow of the pole with these circles both before and after noon. Then if the two points on each circle be joined by a chord the mean of the directions of the middle points of the chords from the pole will be approximately the direction of the meridian line. This method answers best about midsummer when the sun's diurnal path is high in the heavens, and the change of declination is small. A little forethought must be displayed in suiting the dimensions of the circles to the height of the vertical pole employed.

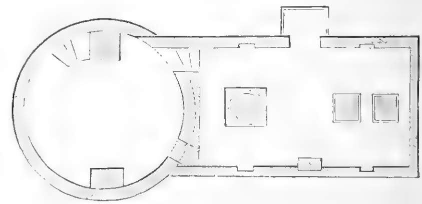

FIG. 1.—Ground plan of the Bedford Observatory.

Foundations.—The foundations of an observatory are a matter of great importance, and unless a rock[1] or chalk bottom can be readily obtained, an artificial bottom of concrete, more or less thick according to the height of the intended superstructure, must be made. This of course applies to the piers which are to carry instruments. In the case of the observatory itself, especially if the material of the fabric is to be of wood, which is so often used, the ordinary precautions against settlement taken by a competent builder will suffice. As no fire-place is permissible in an observatory because of the disturbing currents of air to which fires give rise, special precautions must be taken to protect the building and its contents against damp, and the consequences thereof. In heavy clay soils clear away the soil all around the outside of the observatory by making a trench, say 10 feet wide and 4 feet deep, and fill up the excavation with broken bricks, coarse gravel, or other hard porous material. Provide by suitable gutters and pipes, that all rain-water falling on the observatory shall be carried away to a distance as quickly as possible.

Details of the Structure of the Observatory.—Fig. 1 represents the ground plan and Fig. 2 the elevation of the Bedford Observatory. The external dimensions were about 35 feet by 13 feet 6 inches. The building was divided into two apartments: (1) an equatorial room, circular, and 15 feet in diameter on the inside; and (2) a transit-room, 17 feet by 12 feet on the inside, and 10 feet

[1] A rock foundation is not necessarily the most stable possible, and some authorities deem a sandy substratum best.

high. At Bedford the transit room contained a transit circle and a transit instrument, with a clock so placed that it could be used with either, as wanted; but an ordinary amateur will only need to have one meridian instrument, and the surplus space may advantageously be partitioned off to form a calculating-room, or the

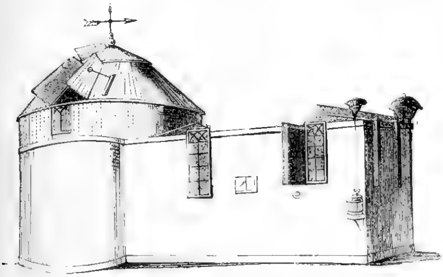

FIG. 2.—Elevation of the Bedford Observatory.

space may be used as an ante-room, and the entrance door put there, and not on the north side, as at Bedford.

It will now be convenient to describe the several parts of an observatory more in detail.

The Equatorial Room.—The equatorial being the principal instrument in every amateur's observatory, the provision made for its accommodation deserves attention first. It is not an uncommon practice to arrange that the floor of the equatorial room shall be 2 feet or 3 feet below the level of the adjoining room, and where a large equatorial is worked with a small transit instrument used merely for setting the clock, and economy and difficulties of site have to be considered, a sunken equatorial room may be unavoidable. But all the same the practice is highly inconvenient and ojectionable. An observer should be able to move rapidly from one part of his observatory to another in the dark, and without having to think of steps up or steps down. Moreover, in order to secure free internal ventilation nothing more substantial than a green baize curtain should separate the equatorial room from the transit room, and it is obviously not safe to use such

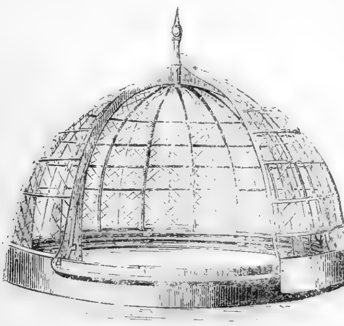

FIG. 3.—Diagram showing ribs of a dome intended to be covered with copper or sheet iron.

a curtain where it will conceal a difference of level of 2 feet or more.

Fig. 1 contemplates an equatorial of what is called the "English" form, with two separate piers for the support of the polar axis; but this construction of equatorial has become almost obsolete, owing to its numerous practical disadvantages, and the "German" form, with one pier and pillar, centrally placed, is now all but universally used, at least by amateurs.

The construction of a roof for an equatorial room (technically called the "dome," whatever may be its precise form) is a great *crux* to the intending builder of an observatory. Theoretically the hemisphere is the proper form, and roofs truly hemispherical are occasionally met with; but they are extremely troublesome and expensive to make, and can only be tackled by professional engineers.

Fig. 3 represents the skeleton framework of such a dome of large dimensions, before the sheet copper, or other material to be employed in covering it, has been been put on. Of late years, especially for large observatories, "drum" domes have come much into use as comparatively easy to construct, and capable of being made strong and watertight; but they offer much resistance to the wind, and architecturally are bound to be ugly.

For the purpose of protecting the smaller sizes of equatorials, say those from 4 inches to 7 inches in aperture, a polygonal dome is recommended. Or, in the case of equatorials of the smallest size, say from $2\frac{1}{2}$ to 5 inches, the roof of the equatorial room may be flat, and arranged to open by sliding it to one side. Such a sliding roof should not be quite mathematically flat but should have a slight inclination, to throw off the rain.

Whatever be the form of the dome chosen the problems,

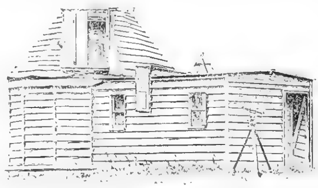

FIG. 4.—Wooden Observatory erected at Eastbourne in 1854.

how to uncover a slit in it, and how to move the whole of it, are matters which require in all cases careful consideration. Where the dome is a large one, say more than 12 feet in diameter, the shutters which close the slit should slide. They may slide laterally on a suitable staging (as in Fig. 4), or they may slide up and down. The latter is a very convenient expedient, especially when the observatory is to be erected in a situation exposed to strong winds, or when the telescope is to be much used on the sun; for the observer can open just so much space as will uncover the whole aperture of the telescope, and can keep himself and the greater part of his telescope protected from the direct impact of the wind, or the direct rays of the sun, as the case may be. When arranged in the best form the shutters will be three or four in number, each protecting a third or a fourth of the slit, measured vertically. Each shutter must have its own rabbet, and its own ropes and pulleys, in order to enable the observer to open at one time only so much of the whole slit as is necessary to enable him to scrutinise the particular portion of the heavens which he desires to examine. The advantage of thus being able to shelter himself and his telescope will soon be appreciated in windy weather, or under a meridian sun by the owner of an observatory fitted with sliding shutters.

Another important matter is the question of the bearings on which a dome is to be mounted. Large domes can only be made to move with facility by the aid of mechanical appliances which are often in practice both complex and cumbersome, and needing much muscular effort on the part of the person who has to move the dome. Where the weight of this does not exceed a ton, a set of grooved wheels running in a concave wall-plate of iron generally works well. For weights beyond this, special mechanical appliances must be used, which it is foreign to my present purpose to treat of. On the other hand, light domes—by which is meant domes up to, say, half a ton—are best dealt with by being mounted on iron balls (cannon balls in fact) travelling on a circular wall-plate, and kept in place by an upper plate, the arrangement being such as is indicated in Fig. 5.

The ironwork may be simplified in character and lessened in weight if the upper plate, which in Fig. 5 is, like the lower one, a solid casting, is replaced by two detached rails about an inch square in section and placed about 3 inches apart. The balls need only be three in number where the diameter of the dome does not exceed 10 feet. If the diameter is greater than that a fourth ball may be desirable in order to distribute better the weight, and lessen the risk of the framework of the dome being strained. The diameter of the balls may be 4 or 5 inches (say 24-pounder or 32-pounder balls), and the more truly spherical they are the less the friction, and consequently the less the muscular effort, required to impart motion to the dome; and to this it may be added the less likely are the balls to approach one another after being some time in use and so in a sense dismount the dome. When this does happen the dome must be slightly prised up by means

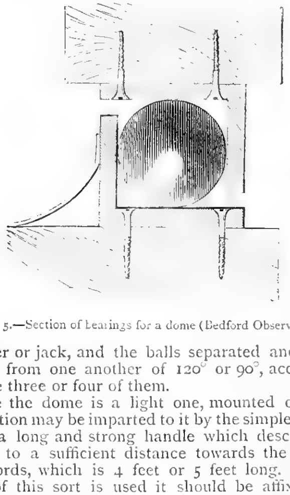

Fig. 5.—Section of bearings for a dome (Bedford Observatory)

of a lever or jack, and the balls separated and set at a distance from one another of 120° or 90°, according as there are three or four of them.

Where the dome is a light one, mounted on cannon balls, motion may be imparted to it by the simple process of pushing a long and strong handle which descends from the roof to a sufficient distance towards the floor; in other words, which is 4 feet or 5 feet long. Where a handle of this sort is used it should be affixed to the dome by strong screws or bolts, exactly opposite the shutters which cover the main opening, because when so placed the observer can grasp the handle and bring the openings exactly to that part of the heavens to which he has pointed his telescope, and can be sure that he has done so. In this facility of being able to watch how far the dome is moved resides the great advantage of the fixed handle; its disadvantage is that the observer in moving the dome has to follow it himself by walking around on the floor. To obviate this inconvenience, such as it is, some prefer a fixed wheel permanently attached to some one place in the wall of the observatory, and having cams in its periphery to catch suitable pins attached at short intervals to the inside circumference of the revolving dome.

Whatever may be the form of the dome, it is evident that in plan it must at the bottom be circular, and that the wall-plate must be circular also, and of the same dimensions. But the plan of the equatorial room, as regards its walls and floor, is another question. Where the room is large, say 15 feet or 20 feet, or more, in diameter, it will be best that it also should be circular, or perhaps octagonal. Where, however, the dome is not more than 12 feet across, and consequently the whole establishment is on a small scale, there are great advantages in making the equatorial room square. In such a case the corners will be found very useful for various purposes: for instance, in one a desk or writing-slab may be fixed; in another, the clock; in a third, a lamp; whilst the fourth corner may take a chair or a stool. In other words, the corners become available as places of refuge for things and persons whilst the observer is turning the dome round from one part of the heavens to another. Moreover, the cost of building a square room is less than the cost of building a polygonal one, because the difficulty is less, be the material brick or wood. If wood is employed for the walls of an observatory, it will in all cases be desirable to place the frame on a dwarf wall of brickwork rising at least 2 feet above the general level of the ground.

The floor must be supported on joists, trimmed so as to form square frames around the piers which are to carry instruments. This will enable the floor-boards to be fixed firmly, yet quite clear of the piers, and will prevent tremors, caused by persons passing over the floor, being conveyed to the piers, and so to the instruments. A free circulation of air must be secured by means of small brass ventilating gratings suitably disposed around the floor near the walls.

Making due allowance for the different purposes for which it is to be used, many of the remarks just made with respect to the equatorial room will apply also to the transit room. The main part of the roof is a fixture, but an opening about 1 foot 6 inches wide has to be made right across the top, and to be continued into the north and south walls from the eaves downwards towards the floor, so as to enable the observer to sweep the meridian with the transit instrument from the south horizon through the zenith to the north horizon. The openings must be protected by shutters, which may either slide or lift. For large observatories Grubb has devised a form of balance shutter which swings, and is said to work well.

In cases where the top transit shutter, which constitutes part of the roof, is in the form of a flap and lifts, it must be counterpoised by a weight or weights travelling up and down inside the room. The vertical shutters must be treated as casements, and be fitted with handles and fastenings accordingly. The remarks made in speaking of the equatorial room as to the advantages offered by sliding shutters or sashes, apply equally to the case of sliding shutters for a transit room.

Light should be obtained for an observatory by independent windows, and not, as in Fig. 2, by panes of glass inserted in the shutters; for glasses are very apt to get broken by the constant moving of the shutters.

The transit instrument as such I need not describe in detail, but it may be worth while to show how a transit instrument is mounted where space is no object, and the instrument is intended for the determination of Right Ascensions rather than for the commonplace purpose of setting a clock.

The transit instrument at Bedford consisted of a telescope of 3½ feet focal length furnished with an object-glass whose aperture was 3¼ inches; the telescope was supported by broad cones forming an axis 28 inches long, the pivots of which rested on covered Y's offering a surface of polished Brazilian pebble an inch in bearing, and which (owing to their bases being hemispherical and working in corresponding sockets) held their proportionate weight, as well as ensured the axis of the pivots being always strictly in the same right line. The Y's were placed on improved chucks whose azimuthal and vertical motions were effectually secured from dust and injury, and left the shoulders of the pivots just sufficient room for moving without friction; the Y's were morticed upon 2 piers of Portland stone rising 5 feet 7 inches above the floor, and which with their bases weighed a ton each. The axis of the instrument was perforated at one end in the usual way for the admission of light from a lamp at night, but it also contained a contrivance for regulating, by means of a milled head on the telescope tube, the light falling on the wires; and there was, moreover, a rack-screen to the lamp for the same purpose. In the optical focus were five principal vertical wires (besides two for the Pole-star) crossed by one horizontal wire; with a slide and divided scale for bringing the axis of the eye tubes exactly over the respective wires, and thereby destroying parallax. This part of the tube was also fitted with a simple means for adjusting the eyepiece to the solar focus, and for taking out the frame bearing the spider lines in case they needed examination or repair. For setting the telescope the eye-end was furnished with two circles, 6 inches in diameter, each provided with a level and showing altitudes and zenith distances. But it is strongly recommended that such circles should in all cases be graduated and adjusted so as to show declinations.[1]

Setting circles attached to the eye-ends of telescopes are so extremely convenient for approximate settings that it is a matter of surprise that they are not more generally used. They are thought to have been invented by Troughton, and to have been first applied in 1816 to the Greenwich transit instrument. As to this, Smyth has a note as follows:—"Mr. Jones lent me a note-book of the late Mr. Walker, of *Eidouranion* memory, in which he describes a visit he made to the celebrated Jesse Ramsden in 1780; and mentions that he was shown an ingenious mode of elevating a transit instrument by a circle of about 3 inches diameter and a level at the eye-end. The vernier fixed and the circle with its attached level movable. To this statement is the sketch of a telescope so fitted, the accompanying portion of which I traced."

FIG. 6.—The transit instrument of the Bedford Observatory, with observing chair and clock.

Meridian Mark.—This is an accessory to the transit instrument, so useful and so convenient that it is a matter of surprise that a meridian mark is not more generally provided in connection with transit instruments. It affords by day, and, if illuminated, also by night, a means of verifying the meridian adjustment of the transit instrument. Fig. 8 represents the meridian mark used in connection with the Bedford Observatory. A plate of brass about 4-10ths of an inch thick, 5 inches long, and 3 inches wide was fastened by four screws, passing through its corners, to a stone, into which four brass sockets to receive them had been made fast by molten lead. On this plate it was arranged that another of the same thickness should slide; this was $3\frac{1}{2}$ inches long by $1\frac{1}{2}$ inches broad, and was attached to the former by dove-tailed side-pieces, and was capable of being adjusted by two long screws pressing against its ends. In the sliding plate there were four slots to receive four capstan-headed screws, by means of which the sliding-plate could be firmly made fast to the fixed plate after the mark had been duly adjusted to the meridian. This done, the end screws were withdrawn to prevent the possibility of their

[1] If information is needed as to how this is to be brought about reference may be made to Challis's "Lectures on Practical Astronomy," p. 26.

being tampered with and the mark displaced from the meridian. On the sliding plate there was soldered a square piece of silver exhibiting a well-defined black cross, the centre of which was to mark the actual meridian. As this cross taken by itself hardly afforded sufficient vertical length for comparing the wires of the transit a small circle of silver (with a black dot in its centre) was placed above the cross as an auxiliary mark. This silver circle, like the larger silver plate below, was capable of lateral motion by means of capstan-headed screws which

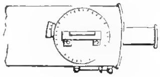

FIG. 7.—Setting circle devised by Ramsden.

could be removed when the dot had been brought exactly over the cross below. The stone to which the mark was fixed was firmly morticed into a dwarf pier, to guard against lateral movement, and the whole superstructure was firmly bedded on a solid substructure sunk into the earth. It is of the utmost importance to guard against settlements likely to cause any lateral movement, for it must be remembered that with a 50-foot radius a displacement of about 3-1000ths of an inch is equivalent to one second. The remaining and important part of the arrangement at Bedford was a 4-inch lens of 49½ feet focus, being exactly its distance from the diaphragm. This lens was mounted in a brass collar, and having been attached by screws to a plate of cast-iron, was let into the wall of the transit window in a line with the transit instrument and the meridian mark. It is evident that the rays of light from the meridian mark become parallel after passing through the lens, and that the diaphragm can therefore be viewed through the telescope of the transit instrument as adjusted to solar focus. Another consequence of the rays being rendered thus parallel, is that no parallel motion of the transit axis would cause a change in the place of the object seen, so that the meridian is a line drawn from the *diaphragm* through the axis of the lens; and provided that these two points remain rigidly permanent, they offer all the advantages of a very distant meridian mark. And after all, a distant mark when obtainable can still be used as a check to the home mark. It will often happen that an observer will be able to find at the distance of a mile or two, or even of several miles, some well-defined line or point—*e.g.* a window sash, or the pinnacle of a church, or a piece of squared stone, which will serve him as a meridian mark for the simple reason that it lies in the meridian of his transit instrument.

Clocks.—A clock is a very important article of furniture in every observatory.

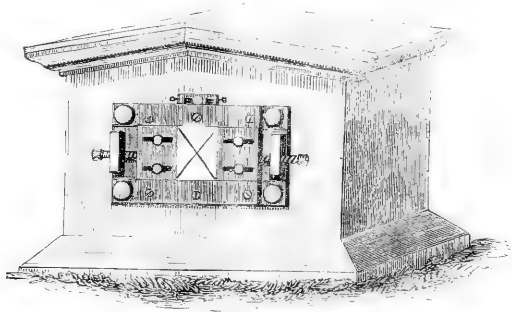

FIG. 8.—Meridian mark.

Whilst a proper sidereal clock showing twenty-four hours is what an amateur should have, he can very easily make shift with a much less pretentious time-piece, especially if his equatorial is provided with the best modern form of driving clock which only requires to be set once, or occasionally, during an evening's work. Indeed all that is essential in such a case is really a good dining-room clock (with its pendulum adjusted to sidereal time) which once set at the commencement of an evening by means of a transit instrument can be depended upon to maintain a tolerably even rate for half a dozen hours. The price of sidereal clocks for observatory purposes has been much reduced of late years, and from 20*l.* to 30*l.* will now command a fairly good one.

Where an observatory includes a transit room the clock should of course be placed so as to be visible both to an observer sitting at the transit instrument and facing the direction in which transits are most usually taken (that is, for the northern hemisphere, south) and also visible to an observer working with the equatorial. This desirable combination makes it expedient that the equatorial room should be at the west end of the buildings; but local reasons connected with the site of the observatory may not always render this possible.

For the clock there should be provided a stone pier constructed and isolated with much the same precautions as those already suggested in respect of the piers prepared to carry the telescope.

On the top of the clock case there is sometimes placed a "Hardy's noddy." This is a small and sensitive inverted pendulum inclosed under a glass bell and standing on a frame provided with three adjusting screws to level it. The use of the noddy is to discover whether the pendulum of the clock imparts any motion to its supports. But this is a refinement with which in a general way amateur observers need not concern themselves.

Meteorological Instruments.—Although an astronomical observatory is one thing and a meteorological observatory is altogether another thing, yet every astronomical establishment should be provided with a few of the more ordinary meteorological instruments, even though their owner does not profess to be a meteorologist. All astronomical observations are in a measure affected by changes in the temperature and humidity of the air; consequently, a self-registering maximum and minimum thermometer, a hygrometer, and a rain-gauge should be regarded as indispensable accessories to every observatory. No doubt, also, the desirability of having a barometer will naturally suggest itself, though its astronomical usefulness is very small indeed—by which I mean that changes of pressure only require to be taken account of in the very exact instrumental observations carried out in first-class observatories. It is also important that a respectable weathercock should be in sight, for the direction of the wind exercises, as is well known, a potent influence on the condition of the air, as revealed by the scrutiny of a celestial object through a telescope.

A good "Six's" thermometer is quite good enough for general purposes, although not a self-registering instrument of the highest scientific precision. As a hygrometer, "Mason's wet-and-dry-bulb" instrument leaves nothing to be desired.

The one special precaution of a meteorological character to be taken in connection with all astronomical observations, whether made in an observatory or in the open air, is that equality of temperature should be secured everywhere. Whilst the due ventilation of the observatory should at all times be provided for, it is absolutely essential, in order to insure good results with every kind of instrument, that all doors and windows should be thrown open, so as to obtain a free current of air everywhere for fully half an hour before observations are to be begun; in hot summer weather, indeed, a longer time will generally be found necessary. The object of these precautions is obvious enough: it is to insure the inside air and the metal of the instruments being cooled down (or, as it may sometimes happen, being warmed up) to the temperature of the external air. In order to learn whether this equality exists, every observatory should have a thermometer outside as well as inside. The former should be hung on the north side, away from the sun, and, if possible, not actually in contact with the observatory itself. G. F. CHAMBERS

(*To be continued.*)

NOTES

WE learn with much pleasure from *Science* the election of Prof. E. S. Holden to be President of the University of California, and Director of the Lick Observatory. Prof. Holden's resignation as Director of the Washburn Observatory at Madison, Wis., takes effect on January 1 next. His appointment as Director of the Lick Observatory will hardly be a matter of surprise to those who are aware that, as consulting astronomer, he has virtually had the direction of the work as it has progressed, visiting the site on Mount Hamilton in 1881, and again in 1883 and 1884. Very happily the choice both of the Lick trustees and of the regents of the University has fallen upon Prof. Holden. It is understood that, in his letter of resignation to the regents of the University of Wisconsin, he strongly urges the name of Prof. W. A. Rogers, of Harvard College Observatory, as his successor.

THE wealthy American, Senator Stanford, proposes to establish a Californian University. He intends to give to it, besides estates worth 5,300,000 dollars, a donation in money increasing its endowments to 20,000,000 dollars. The University will be located at Palo-Alto, thirty miles from San Francisco, and is apparently to be modelled somewhat after the plan of the Johns Hopkins institution.

THE prospectus has been issued by Herr Fischer, publisher, of Jena, of a new scientific periodal entitled *Zoologische Jarhbücher: Zeitschrift für Systematik Geographie und Biologie der Thiere*, which is to be brought out under the editorship of Dr. J. W. Sprengel, of Bremen. Notwithstanding the vast number of scientific journals, both author and publisher think that this department of science does not receive the attention which it deserves. It is not excluded, they say, from scientific periodicals; but communications relating to it appear more or less as strangers by the side of others. The new periodical will be wholly devoted to this class of subjects. In the first section the papers will, for the most part, be of a higher kind than the mere description of new species, except those for which no special journal exists. The geographical section will contain studies on the distribution of all kinds of animal and vegetable life, and special attention is promised to the biological section. Contributions will be received in German, French, English, and Latin. The periodical will appear quarterly, each four issues making a volume.

THE success of the last electrical exhibition at the Paris Observatory was so complete that the International Society of Electricians is preparing another for next spring.

A GENERAL meeting of members of the French Association for the Advancement of Science has been summoned to approve of the fusion with the Société Française. Lectures and meetings will take place this year under the patronage of the united societies as a single body.

THE well-known electrician, Dr. James Moser, who was working for some time at Prof. Guthrie's laboratory, has been appointed as *privatdocent* at Vienna University.

THE Colonial fisheries are to form a prominent feature at the Indian and Colonial Exhibition which is to be held next year. The Aquarium will be considerably enlarged, and special tanks are now being prepared for the reception of the various fish from the Colonies. A tank of colossal proportions is to be allotted for the purpose of exhibiting turtles in large numbers which will be despatched from India together with other specimens in the early part of next year. We do not yet know what fish are to be forwarded from the various colonies, but the utmost care will have to be exercised and the most perfect arrangements made in order to provide for their various necessities. The collection promises to be one of great interest and value, although its success all depends upon how the fish withstand the long journeys to which they will be subjected.

TOWARDS the end of October the remarkable sun-glows were again seen at Stockholm. In the western horizon a yellow cloud-bank, strongly illuminated, appeared behind a number of tiny clouds, greyish in colour, the sky above the former, to a height of about 45°, being lurid, entirely colouring the clouds. Later on in the evening the glow imparted to the edges of the clouds the most remarkable reflections of colour, varying from ochre to yellow, violet, and pink, with shadings of blue. At times the higher-lying clouds formed most remarkable formations. It seemed that the glow was situated between cumulus and cirrus clouds.

ON October 21, at about 5 a.m., a brilliant meteor was observed at Skaadö, on the south-east coast of Norway. It appeared first near the zenith, and describing a circle of about 70°, disappeared in the south-west, about 20° above the horizon. In spite of the sky being covered with clouds, and its being still dark, the country around was lit up as in daylight, objects being clearly discernible at a great distance. As no sound or explosion was heard, it is assumed that the track of the meteor lay in the upper parts of the atmosphere.

SOME Thames trout are being spawned at Sunbury by the Thames Angling Preservation Society, who are doing their utmost to replenish the stock of this fine species of Salmonidæ, which, unhappily, have now become a rarity. The ova will be incubated by the National Fish Culture Association, and the fry will ultimately be deposited in one of the Thames nurseries.

THE Catalogue of the Library of the Royal Society of Tasmania is a considerable volume; and it is a matter of some surprise to find that men of science in this distant colony have such an excellent library as this. It embraces every class of literature, and appears especially rich in periodicals, and in works relating to Australasia.

THE last "Circular" of the Johns Hopkins University Library contains a list of the periodicals, including the scientific and literary publications of various societies, regularly received. Although newspapers and official reports are omitted, the list extends over eleven closely-printed columns, and probably contains the name of every periodical in the world in any way connected with science.

AN interesting bi-monthly periodical has just made its appearance in Colombo. It is entitled the *Taprobanian; a Dravidian Journal of Oriental Studies in and around Ceylon in Natural History, Archæology, Philology, History, &c.*," and is edited by Mr. Nevill, F.Z.S., of the Ceylon Civil Service. The first number contains various notes and queries, relating mainly to scientific subjects, and articles on Tamil inscriptions in Ceylon, comments on Ptolemy's geography, on Ceylonese inscriptions in the Asokha dialect, archæological reports on Ceylon (No. 1), and on the Vaedda dialect. The whole of the contents of the thirty-two pages of the first issue is from the pen of the editor, who hopes to make his periodical a storehouse of details, available hereafter for the elaboration of any special subject connected with the Tamil and other Dravidian races. He promises to do his utmost to procure for investigators in Europe, America, or elsewhere, any local information of scientific interest that they may seek. We hope the venture will have the success which the editor's learning and enterprise so well deserve.

WE are glad to notice the re-appearance of the *Orientalist*, another Ceylon periodical, containing articles of much scientific interest, and which has been noticed in NATURE. It ceased publication for some months, but the editor is now publishing double numbers to make up for lost time, which, it is only fair to add, was due to negligence of subscribers, not to that of its learned editor.

THE present number (x. No. 23) of *Excursions et Reconnaissances* of French Cochin China contains the fourth part of M. Landes's article on Annamite tales and legends; but it is mainly occupied with the continuation of M. Tirant's long account of the fishes of Lower Cochin China and Cambodia.

THE inhabitants of Srinagar, Cashmere, have again been thrown into a state of alarm and consternation at the recurrence of earthquake shocks there. The first shock—a severe one—was felt on the night of the 15th inst., and this has been followed by a constant series of slighter ones.

THE last number of *La Nuova Scienza* contains instructive papers on "Modern Italian Thought," on "Cosmic Evolution," and on the "German Pessimist Philosophy." The first of these papers deals with Prof. G. Sergi's "Origin of Psychic Phenomena" (Milan, 1885), which forms the fortieth volume of the Italian "International Scientific Library," and which contains a useful summary of the arguments of physiologists and psychologists on the genesis and nature of psychic force. Sergi contends that psychis is merely a function, or rather an implement of the body, analagous to the teeth, claws, and other offensive and defensive members. Against this materialistic conception Prof. Caporali, author of the paper in question, and editor of *La Nuova Scienza*, contends that pscyhis is inherent in all forms of matter, from the atom to the highest organisms, and that it is the cause, not the effect, of motion, that is, of all progress and evolution. It is an error to suppose that the organ originates the psychic function, for the function precedes the organ. The lowest organisms, such as the amœbæ, have no differentiated organs, yet they exercise psychic functions, as shown by O. Zacharia in his new work on "Organismen ohne Organe" (1885). Hence, to regard psychis as a mere function of the body, and introduce it later into the fully-developed nervous system as the product of the system, is neither philosophic nor scientific. The article on the German Pessimist school contains biographical notices and short summaries of the teachings of Schopenhauer, Von Hartmann, Geiger, Noiré, and other exponents of that philosophy. The *Nuova Scienza*, which continues to be conducted with remarkable learning and ability, deserves more general recognition than it appears to have yet received in this country.

TELEGRAPHS are extending with extraordinary rapidity over Southern China. At the present moment Pekin in the far north is connected by a direct line through Canton with Lungchow on the frontier of Tonquin, the extension from Canton to the latter place being made during the recent war, purely for military purposes. Thus we have one great line stretching through the Chinese Empire from north to south, and at the present moment an important line is being constructed along the southern borders of China through the provinces of Kwangtung, Kwangsi, and Yunnan. Starting from Nanking in Kwangsi, where it joins the Canton-Lungchow line, it will extend for nearly 600 miles to Mung-lih in South Yunnan, running for half the distance along the Yukiang, the name of the Canton river in its upper course. The work is being carried out by the Chinese themselves with the assistance of one European, and it is stated that during the recent war the Canton authorities equipped a complete field telegraph staff, the members of which were so thoroughly trained that they have been able to put up 35 miles of line in a single day for war purposes. Telegraphs have now secured a firm footing in China, and their extension over the whole country is a matter of time only, aided perhaps by political events. In the great movement towards a centralised Government now progressing in China the telegraph line will play a vital part, for it will utterly destroy the semi-independence of the provincial viceroys, hitherto secure in their remoteness from the seat of government.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♀) from West Africa, presented by Miss Hodgson; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Berens; an Arabian Gazelle (*Gazella arabica* ♀) from Arabia, presented by Mr. John Patton; two Short-headed Phalangers (*Belideus breviceps* ♀ ♀) from Australia, presented by Mr. P. S. Abrahams, F.Z.S.; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mrs. Morgan; two Indian Cobras (*Naia tripudians*) from India, presented by Mr. W. G. Burrows; two European Tree Frogs (*Hyla arborea*), European, presented by Mrs. A. Bratton; two Catfish (*Amiurus catus*) from North America, presented by the National Fish Culture Association; two Mule Deer (*Cariacus macrotis* ♀ ♀) from North America, a Triton Cockatoo (*Cacatua triton*) from New Guinea, deposited; two Barbary Wild Sheep (*Ovis tragelaphus* ♂ ♀) from North Africa, four Spotted-billed Ducks (*Anas pœcilorhyncha* ♂ ♂ ♀ ♀) from India, purchased; a Sambur Deer (*Cervus aristotelis* ♀), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, NOVEMBER 22-28

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 22

Sun rises, 7h. 33m.; souths, 11h. 46m. 22·9s.; sets, 16h. 0m.; decl. on meridian, 20° 15′ S.: Sidereal Time at Sunset, 20h. 7m.

Moon (at Full) rises, 16h. 43m.; souths, 0h. 25m.*; sets, 8h. 14m.*; decl. on meridian, 17° 1′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	9 32	13 9	16 46	25 32 S.
Venus	11 28	15 8	18 48	25 13 S.
Mars	23 31*	6 31	13 31	10 54 N.
Jupiter	1 53	8 0	14 7	0 40 N.
Saturn	18 19*	2 27	10 35	22 21 N.

* Indicates that the rising is that of the preceding and the southing and setting those of the following day.

Occultations of Stars by the Moon

Nov.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
22	θ^1 Tauri	4½	18 29	19 17	33 272
22	θ^2 Tauri	4½	18 38	19 9	6 299
22	75 Tauri	6	18 49	19 8	133 172
22	B.A.C. 1391	5	19 18	20 17	60 246
22	Aldebaran	1	21 48	22 57	75 257
23	117 Tauri	6	17 59	18 42	29 271
24	130 Tauri	6	2 52	3 58	92 323
24	26 Geminorum	5½	22 59	0 6†	54 241
26	1 Cancri	6	5 40	6 46	107 292

† Occurs on the following day.

For further particulars in regard to the occultation of Aldebaran see NATURE, vol. xxxii. p. 610.

Phenomena of Jupiter's Satellites

Nov.	h. m.		Nov.	h. m.	
22	3 42	I. tr. egr.	26	4 19	II. occ. reap.
23	6 43	III. ecl. disap.	27	4 2	III. tr. egr.
24	7 18	II. tr. ing.	28	5 9	I. ecl. disap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Nov.	h.	
24	23	Saturn in conjunction with and 3° 59′ north of the Moon.

A special watch should be kept on November 27 and the days immediately preceding and following, in order to note whether there is any recurrence of the meteoric shower observed on November 27, 1872, and believed to be connected with Biela's comet. The radiant point is near γ Andromedæ.

CHEMICAL NOTES

In order to obtain constant temperatures easily maintained and completely under control, Messrs. Ramsay and Young (*C. S. Journal, Trans.*, 1885, 640) employ vapours of the following compounds, and alter the pressure to which each vapour is subjected: carbon disulphide, ethyl alcohol, chlorobenzene, bromobenzene, aniline, methyl salicylate, bromonaphthalene, and mercury. By the use of the vapours of these bodies at various pressures, any desired temperature between that of the atmosphere and 360° can be easily obtained. The authors have very carefully determined the vapour-pressures of these compounds for a large range of temperature. The methods of experiment are fully described, and the results are presented in the form of tables, which must prove of much service to those chemists and physicists who have occasion to raise pieces of apparatus to a known temperature, to vary that temperature if required, or to keep it perfectly constant for an indefinite period.

As was noticed in these columns some time ago, Dixon has recently proved that a mixture of perfectly dry carbon monoxide and oxygen is not exploded by the passage of electric sparks; but that the presence of a minute quantity of water suffices to determine the combination of the gases. Dixon supposed that the action of the water was as represented in the following two equations:—

$$(1)\ CO + H_2O = CO_2 + H_2,$$
$$(2)\ 2H_2 + O_2 = 2H_2O.$$

Now Traube (*Ber.* 18, 1890) has shown that carbon monoxide does not decompose water in complete absence of air or oxygen, even at very high temperatures; he has also shown that when moist carbon monoxide and oxygen are exploded together, hydrogen peroxide is an invariable product. Traube suggests that the following three changes probably occur during the explosion in question:—

$$(1)\ CO + 2H_2O + O_2 = CO(OH)_2 + H_2O_2.$$
$$(2)\ CO + H_2O_2 = CO(OH)_2.$$
$$(3)\ 2CO(OH)_2 = 2CO_2 + 2H_2O.$$

When hydrogen is burnt in moist oxygen, hydrogen peroxide is always produced, according to Traube. Whether a perfectly dry mixture of hydrogen and oxygen could or could not be exploded by electric sparks cannot be regarded as settled; Traube thinks that such a mixture would prove to be non-explosible. He regards the mutual action of hydrogen, oxygen and water as in all respects comparable with that of carbon monoxide, oxygen, and water, or with that of zinc, lead, and some other metals, oxygen, and water. The changes which occur in the explosion of moist hydrogen and oxygen are formulated by Traube thus:—

$$(1)\ H_2 + 2H_2O + O_2 = 2H_2O + H_2O_2.$$
$$(2)\ H_2O_2 + H_2 = 2H_2O.$$

The occurrence of the second part of this reaction has been experimentally demonstrated by Traube.

In continuing his experiments on nitrification, Warington (*C.S. Journal, Trans.* 1885, 758) has shown that the limit of concentration (about 12 per cent.) beyond which urine ceases to be nitrifiable under ordinary conditions may be largely extended by adding gypsum to the liquid. A solution containing 50 per cent. of urine, and 22 milligrams of gypsum for every c.c. of urine, began to nitrify after about five months; solutions containing 15, 20, and 30 per cent. of urine began to nitrify after the lapse of 53, 68, and 78 days respectively. The gypsum prevents the accumulation of ammonium carbonate in the liquid.

J. H. van't Hoff describes (*Berichte*, xviii. 2088) experiments on phenomena, analogous to those exhibited by gases at their "critical points," occurring during chemical decomposition. Phosphonium chloride, PH_4Cl, which melts at 25°, was heated to 50°-51° at a pressure of 80-90 atmospheres in a Cailletet's apparatus; under these conditions the line of separation between liquid and vapour disappeared, and, on cooling, the formation of nebulous streaks became plainly visible. It is well known that the vapour obtained by heating PH_4Cl under ordinary conditions consists of $PH_3 + HCl$; it is not possible to say to what extent the melted substance in van't Hoff's experiment consisted of a compound of PH_3 and HCl, and the gaseous part consisted of a mixture of these constituents, yet it seems certain that, when PH_4Cl, a compound which is chemically decomposed when vaporised, is heated to 50° under a pressure of 80-90 atmospheres, there exists identity between the vapour and the condensed portion of the body.

La Coste describes (*Berichte*, xviii. 2122) a modification of V. Meyer's apparatus whereby the densities of easily decomposed compounds may be determined at low temperatures under small pressures.

GEOGRAPHICAL NOTES

A catalogue of the printed maps, plans, and charts in the British Museum has been prepared by Prof. Douglas, and will be issued in two large volumes. It represents the contents of the manuscript catalogue in 323 volumes, the catalogue of the maps and plans in the Royal Library in two printed volumes, and the manuscript catalogue of charts in the same library. The original manuscript catalogue was made under the superintendence of Mr. Major, late Keeper of the Department of Maps. The orthography adopted in the present catalogue is that used in Keith Johnston's "General Dictionary of Geography," with the exception of India, for which Hunter's "Gazetteer" has been taken as a guide. The utility of this catalogue to the geographical student will be found in the comparatively simple alphabetical arrangements for the headings of countries and places, combined with the names of geographical writers, which last often serve as short cuts to any particular atlas or map. Thus, under the head of "Ptolemy," the pillar and foundation of ancient geography, there are seventy-four entries referring to the various editions and copies of his "Geographica." Turning to the names of the fathers of modern geography, Ortelius and Mercator, we find under the former twenty-nine entries describing the various copies and editions of his "Theatrum orbis Terrarum." The geographical labours of his contemporary and friend, Mercator, will be best realised by a reference to the heading "World: Atlas: Modern," p. 4491, where will be found probably the most complete list of Mercator's atlases extant, ranging from 1495 to 1636.

AT the meeting of the Geographical Society of Paris on the 6th instant, M. Germain, who presided, pronounced a eulogium on Milne-Edwards. M. Duveyrier called attention to a report addressed to the Spanish Government by Capt. Bonelli, relative to the Spanish possessions on the West Coast of Africa, according to which it appeared that the writer claimed on behalf of Spain nearly a hundred kilometres of the coast belonging to the French in Senegal. A letter was read describing the departure from Buenos Ayres of M. Thouar on a new expedition to complete his work on the Pilcomayo. A note was read from M. Venukoff on the recent incidents of Russian geographical exploration. M. Chaffaujon described his late explorations in the basin of the Orinoco, to which we have already made frequent reference.

THE current number of *Petermann's Mittheilungen* has for its first article a lengthy communication by Dr. Theodor Fischer on the development of coasts. His conclusion is as follows:—Wherever the sea by breakers and currents has exercised a preponderating influence on the form and development of coasts, whether flat or precipitous, the line of coast takes the form of a succession of arcs, in the case of steep coasts with a short, and of flat coasts with a long, radius; where the coasts exhibit other features than these, although the action of the sea be not wholly excluded, yet other causes, especially tectonic alterations in the surface and movements of the earth's crust, are more powerful or are very recent. Herr Langhaus gives a map of the Cameroon Mountains, with an accompanying description, containing a short sketch of recent exploration in the region. Dr. Boas writes on the topography of Hudson's Bay and Hudson's Straits, with a map; and Herr Wichmann describes the new republic in South Africa, also with a small but remarkably clear map by Dr. Havernick. The usual geographical and critical notes and lists conclude the number.

M. EUGÈNE AUBERT has been charged by the Ministry of Public Instruction with a scientific mission to the basin of the Amazon.

BEES AND OTHER HOARDING INSECTS[1]

Their Specialisation into Females, Males, and Workers

IN discussing the differentiation of bees into females, males, and workers, I shall have no need to call your attention to any new discoveries in the world of wonders among those minute creatures that we have had with us for all ages, and whose life we are just now beginning faintly to understand. My illustrations will be drawn mainly from other orders, in which it will be impossible for me to make a mistake without its being readily seen by some of the general public as well as the specialists.

The limits of this paper will not permit elaborate definitions, or fine discriminations, and I have therefore to ask that you will kindly make your own definitions, taking care to give to my words in general the narrowest sense compatible with the use to which I apply them.

From the creatures and the plants, that man has domesticated for his use, we have learned nearly all of the lessons in heredity, which we have no good reason to unlearn, and my first illustration shall be from one of these, the barn yard fowl.

If we mate a Black Spanish fowl with a Buff Cochin, and hatch out the eggs as the bees do theirs, in an incubator, till we have a hundred chicks, among these we shall find a very great diversity. Some when fully grown will be nearly, if not quite, as heavy as the Buff Cochin, and some will weigh little, if any, more than the Black Spanish. Their respective weights will probably vary between those natural to their sex in the two varieties to which their progenitors belong, but much the larger number will be very nearly half way between. And as colour is not necessarily correlated with weight, it is quite possible that the heaviest chick will be the blackest; that is to say, that he may take his colour almost entirely from one parent, and his weight and form from the other. In colour every one of the hundred chicks will, when fully grown, be in some degree distinguished from every other; and if we take colour, size and form together for our guide, there will not be one among the whole number that we cannot readily distinguish from every other. Now this particular cross from the great difference in size, form and colour of the parent stock enables us to see very clearly a fact which the closest and most careful investigation shows to be a general law. It is this:

All offspring are variable by heredity. And under some circumstances the variations are wide.

Nearly every youth, who has amused himself with an aquarium, knows that he can dwarf his fish if he chooses to do so. Other things being equal, the weight of a fish depends upon the amount of food it is allowed to consume. This variability is so great among fishes, that of two as nearly alike as possible, either one may be fed so that he shall exceed a pound in weight, before the other, receiving very little food, shall turn the scale at an ounce.

Thus insufficiency of food affects the development of all organs. All breeders of animals have some knowledge of this fact as applied to their own business, and of which our fish merely affords a striking example. It is an inevitable deduction, that when the food is of the general quality which is suitable for the due nourishment of all the organs but is insufficient in amount, the stronger organs, if such there be, will take more than their share, and the weaker organs will go to the wall. From this matter of food supply we have a general law, which may be stated as follows:

Living creatures are variable from the amount and quality of their food. And among some orders the limits of this variation are wide.

It is scarcely necessary for me to go into the fact that the insects, being exposed to more extreme vicissitudes than the larger orders of animal life, are much more variable in almost every respect. It will be interesting, however, and it may be instructive in the line of our inquiry, to point out some powers of variation in sex in a very common plant, which, while they are very much greater than those of the bee, have some points of striking resemblance.

Indian corn is pictured to the unobserving mind as a plant bearing something good to eat at the side and a tassle on the top. The botanist tells us that the tassle on the top is a male plant, that at the side is a female plant or perhaps more than one, that all these are joined upon one stalk, and that the something good to eat is the product of the female plant, fertilized by the pollen of the male. All this is fact as far as it goes; but it gives us no conception of the whole truth.

On going into the field in bloom we find that nearly all of the stalks have tassels on the top; they are male plants. In a good field we shall find perhaps half of them with reproductive females at the side, say two good ears of corn to a hill. There are, therefore, nearly twice as many perfect males as there are of perfect females. We find also that the undeveloped females are very numerous—from one to half a dozen on a stalk. And a close examination shows that the number of females that become developed is almost entirely a matter of food. Such an investigation shows also some plants bearing only a female on the stalk and some that are entirely undeveloped in both sexes.

Thus in our field of Indian corn we have male stalks, male and female stalks, female stalks, neuter stalks. And the stalks that bear developed male and developed female individuals all have (*a*) a male individual on the top, (*b*) one, two, or three females at the side, (*c*) one to six undeveloped females at the side, and possibly with, possibly instead of these (*c*) they may have (*d*) one to half a dozen buds and germs of females at the side.

If, when the corn is ripe, we go with the farmer and gather a basketful, we shall invariably find that on each ear there are kernels less perfectly developed than others, and we shall have every reason to believe that in the basketful there are some kernels that could not reproduce, that some kernels would reproduce but would, under the most favourable circumstances, give but imperfect offspring, and that there would be a very wide range in the degrees of the imperfection of the plants produced from these imperfect kernels.

As a matter of fact, the farmer in planting, selects with care the most perfect ears, and the most perfect parts only of the ears so selected, and yet we have the males, the females, and the neuters or the undeveloped for the result as I have described them.

Indian corn is so extremely variable in this matter of sex, that careful experimenting in this direction would be likely to give most interesting results in a single lifetime.

[1] Read before the Brooklyn Entomological Society, December 29, 1884, by Edwin A. Curley.

Having now illustrated some principles of variability, and given some idea of the extent to which it may go, under our own observation, we must deal with the question before us by way of hypothesis.

Let us suppose a primitive or typical Bee among the honey-seeking insects of early days. She is necessarily a creature having such attributes as are common to all species of bees which are her offspring, but in many respects she is very unlike our Hive Bee of to-day. We see her at a time when this typical species has already learned the wonderful lesson of thrift. She stores honey in times of plenty to provide for times of want. She is feeding her offspring from her stores. As the keen competition of life goes on, she must provide for the wants of her offspring for an ever-increasing period, and, as her powers in this respect are taxed to the utmost, her powers of reproduction are of necessity diminished; she produces some imperfect eggs, and she produces fewer eggs. Still, the vast majority of her offspring perish, either for lack of sufficient food or as prey to natural enemies before their power of self-defence are sufficiently developed for successful flight or resistance.

It is quite reasonable to suppose that the bee has been subjected to such vicissitudes as these. The extraordinary differences in the sizes of the various living species of bees would indicate the truth of the theory of insufficient food as far as we have yet followed it. If we have a species of bee only one-eighth of an inch in length while some others are an inch and a quarter in length and stout in proportion, it will take one thousand (1000) of these Lilliputian bees to weigh as much as a single specimen of one of these largest species. Is it not most reasonable to suppose that this tremendous variation in size is chiefly due to the matter of food supply, as is the well-known fact in the very large variation we can thus make in the size of an individual fish?

Now when the food supply is so very scant that the size of the offspring is necessarily much dwarfed, evidently the weakest will die in the process of rearing; evidently also the mother-bee whose reproductive powers are the weakest as to the number of offspring, and whose maternal instincts are the strongest, that is to say, the one that lays the fewest eggs and takes the best care of her young, will best succeed.

If any broods of young perish altogether from famine, it will be those that are so numerous as entirely to overtax the powers of the mother-bee in feeding them. Thus we gradually approach a time when the care of the mother-bee extends to a period in the life of the offspring when they appreciate and respond to her affection. The offspring are still numerous and the struggle for existence is severe. The food supply is sufficient to bring the young to that point in existence when they are capable of applying with some prospect of success the instinct, that is to say, the congenital knowledge, inherited from the mother. And as the mother-bee continues after this period to help them in their struggle for existence, they see and understand her assistance, and they necessarily respond to her affection. Here is definitely established filial love, in response to maternal affection, and it is necessary that this filial love should be established in strength even in this little insect before it is possible that the specialization under consideration shall commence. It must not be supposed that the size of these tiny creatures renders them incapable of this strong feeling—we must in this respect as in others go by the evidence of our senses and the necessities of the case. Without strong affection the whole life of these bees is quite inexplicable, while with it their conduct is the natural outcome of a certain amount of intelligence applied to certain conditions of existence.

Among all creatures nursed with a mother's care, filial love grows stronger and stronger according to the capacity and circumstances of the offspring and the strength of that affection which calls it forth. But when the time for mating approaches the young seek other relationships and so far as it is incompatible with these does filial love decay.

But what happens if the young are by nature incapacitated for these other relationships?

Then filial love necessarily grows with the individual and strengthens with her strength.

The mating instinct may be almost or wholly lacking; and, if wholly lacking, then all of that part of the highly nervous organization inherited from the mother that is devoted to the affections will have no other outlet than in filial love.

The common life around us, and man himself will perhaps afford us some partial illustrations of this necessary law. The best illustration outside of the insect world is one of which the facts may be easily ascertained by any person who will make the inquiry.

The breeding of mules is an important industry. The horse and the ass are capable of strong affection, but their colts seldom develope a filial love which has a controlling influence on their adult life.

But the mule, the hybrid between the male ass and the female horse, except in very rare instances, is congenitally incapable of reproducing its kind. It has more or less of the instinct for mating, but it necessarily does not have the strong sexual passion of a perfect equine animal. Its love for its mother however amounts to a master passion; it is not spasmodical, but it is intense and it continues as long as there is an opportunity of showing it. It is capable of transfer to another object and those who breed mules in large numbers take a useful, instructive, and amusing advantage of this fact.

When the young mules are weaned, the mothers are withdrawn from their company, and one, otherwise worthless old mare is substituted for many mothers. The poor young things turn to the good-natured old mare as to a very goddess; while she receives their worship with the equanimity of her sex, never hinting in the mildest terms that it is an idolatry that should be abated. As the dilapidated goddess herself may be depended upon for her staid qualities, it follows that her worshippers are thereby kept out of mischief. And the poor mule is not a backslider, it is always a consistent worshipper.

I have stated that filial love is absolutely necessary to the specialisation under consideration. It should be added that it must be intense in its character and capable of replacing to a large extent the maternal instinct of the perfect creature.

From the fact that insufficiency of food would affect the growth of all organs we deduce the further fact that it would affect weak organs the most, giving those not congenitally perfect an irregular development. It follows also that if a very young animal congenitally perfect, receives for a long period only sufficient food to sustain life, the organs not vital will be more or less dwarfed in their proportions, as compared to the vital organs.

For here the law of parsimony is absolute. The vital organs *must* receive a certain supply, or the life perishes. The non-vital organs make no such imperative demand, and they consequently get less in proportion. And an organ that is entirely useless to the life of the individual, would under such circumstances receive no nourishment whatever; excepting only as it is correlated to the organs that are useful or vital. The reproductive organs of the young of all species are entirely useless to the life of the individual; their powers are latent, and, excepting as they are correlated to other organs, they make no demand for nourishment. Starvation must therefore dwarf the reproductive organs of very young individuals, in proportion to those which are very important, or absolutely necessary to life. In plants this fact is constantly shown all around us and our maize is a striking example.

The reproductive powers of swine are very great. But a young pig that is half-starved will not only have its reproductive powers very much retarded in their growth, it will have them diminished in their ultimate strength. This is a matter in which general observation furnishes the proof. I have not asked fish-culturists the question but I am absolutely certain that, other things being equal, the number of fish-eggs will depend upon the size and thrift of the individual, and these, other things being equal, depend upon the question of food.

It is easy to imagine a possible case among the vertebrates or even the mammals in which a perfectly normal organism by long continued insufficiency of food, is allowed a slow development of those organs that are absolutely necessary for its life, and of the others most nearly correlated to these, while the organs of reproduction, in the incipient or undeveloped stage in which they were when starvation commenced, still remain till they become fixed and immutable, notwithstanding any abundance of food that may be given at a later period of life.

Let us now go back to the variability of eggs as shown by our hundred chicks or the variability of seeds as shown by our ears of corn. This variability is variability of the germs, and this is congenital variability. This variability as shown in the hundred chicks gives us from three to six pounds for their adult weight and they all differ in colour, form, or both.

We take no account at present of the fact that our primitive bee as shown by her offspring of to-day was far more variable than fowls, but we note that she was a hoarding insect, gathering with great care and industry in good times food for times of scarcity; that she supplied her young from her stores; and that they responded to her maternal cares with filial affection.

We left her at a time when the struggle for existence was keen and some of her offspring starved through no fault of her own. She was exhausted with a constant search for food and the cares of a numerous and starving family.

This necessarily involved the fact that her reproductive system was quite out of balance, she was incapable of producing as many eggs as her progenitors, and many of those that she did produce were imperfect.

Of these imperfect eggs some addled and some hatched out imperfect offspring.

At this point we proceed to inquire into the nature of the imperfections of the offspring.

There would probably be quite a variety in these defects. One might be wanting in legs, another deficient in wings, another insane, another deaf, another possibly congenitally blind, or perhaps wanting in that sense, whatever it is, by which ants and bees intelligently converse with their fellows.

All of these and many other congenital defects are possible and even probable, because we see them in other and the least changeable orders and species of creatures.

But the greatest in number of all the very important defects would be defects of the reproductive organs; because they are the organs in the mother which have been most affected by her unfortunate environment.

Under these circumstances, what must become of all the imperfect offspring in a sharp struggle for existence?

Manifestly all wanting in legs, or wings, or eyes, or in any organs necessary for quick and intelligent movements in attacking or resisting enemies, or in collecting food, must die at an early age, notwithstanding any possible care of the mother.

Manifestly none of those defective in the reproductive organs would so die, unless they were also defective in some other particular, unless indeed the struggle became so keen that perfect and imperfect went to the wall together.

Manifestly also these insects thus congenitally imperfect in the reproductive organs would have a great advantage over all others in the struggle for existence, *from the time at which the reproductive period in those others commenced.*

If altogether incapable of reproduction, they would have vitality enough for themselves and a surplus to expend.

The energy inherited from the hardworking progenitors would be too great for idleness. The surplus must be expended at the dictates of love or hate. Hate, beyond that healthy indignation at attack or imposition which is necessary to self-protection, is unnatural to such beings.[1] But they have one to love, and that is the mother. The perfect offspring depart to reproduce their kind, and the one, two, three, or the dozen of the imperfect ones, stay behind with the mother bee, or if she dies they transfer their affection to some one of their perfect sisters.

Now another hoard of honey must be gathered, and another lot of eggs laid, hatched out and cared for. The female bee works industriously and, true to her instinct, denies herself of necessary food that she may lay by the more for her future offspring.

And now these creatures, happy in their deprivation, capable of supplying their own wants with ease, insist on gathering food for the mother-bee. She takes it with eagerness, tastes and stores it away. And after the young are hatched out, the like attempt to feed the mother-bee results in feeding them. Thus this family have for a time a great advantage in the struggle for existence and there is a perfectly adequate motive for the conduct of the kind little creatures who minister to the wants of the mother-bee.

Still this happy family is not precisely the foundation of our modern bee-hive; it is really too affluent for complete success.

The mother-bee, no longer overworked, recovers her health and unfortunately lays perfect eggs; with the help of the nursemaids she rears her young without overtaxing her powers. Her family and any others like it have very decided advantages over the old type, to which nevertheless they inevitably revert, to fall into a state of starvation as before; for, in this family, the nursemaids have, and can have, no probable successors while there is plenty to eat.

If this happens to one family of bees, it will probably happen to many families. The temporary affluence of one family caused by the presence of the helpers will itself increase the depth of poverty in the neighbouring families, and this poverty will give them helpers in undeveloped bees in the next generation, by which in turn they will be raised to affluence. Thus there will be alternating generations of bees—that is to say, generations with helpers, followed by generations without them.

Among those that go forth from the mother-nest to find mates and rear families of their own are some that are congenitally weak in the reproductive organs. The majority of these meet with sound mates and the variation dies out. But some individuals thus congenitally imperfect meet with like mates. The congenital weakness of the reproductive organs is intensified in the offspring. The majority are perhaps so imperfect as not to be able to reproduce their kind. Any of these that reach maturity will be glad helpers of the mother-bee.

Their less imperfect brothers and sisters are defective in many degrees. The offspring of one never reach maturity. Those of another nearly all thrive and there are a dozen reproductive females among them.

In their migrations at swarming time these bees sometimes become established near less affluent families, congenitally perfect, and are sometimes crossed with them.

Here we have the bees in a condition of the greatest variability as to reproductive powers, but all of those that are getting on well in the world have among their offspring some that cannot reproduce, and helpers are consequently numerous.

About this time the paupers are established as a distinct variety. Sick and discouraged with the unsuccessful battle of life, they are more or less tolerated in the affluent families of their neighbours. But when they have recovered their bodily strength, they have not also regained their mental balance. They have become accustomed to a life of tolerated dependence; so they live in the nest and lay eggs to be reared by their industrious neighbours. Sometimes the imposition becomes too great for good nature to stand and there may be a terrible slaughter of the innocent paupers and their offspring. The ones however that most nearly resemble the useful members of the community escape destruction and thus are established the Cuckoo-Bees, their simulation of virtue being ever the closer as indignation increases at their vice.

The varieties become extremely numerous; many of them however becoming rapidly extinct. At first in all families where there are helpers there are almost or perhaps quite as many undeveloped males; but this being for bees a hurtful variation the tendency of natural selection is to their diminution. On the whole those families are the most successful in which there are the largest number of undeveloped females.

All this time experience is being gathered in the mothers and differentiated and stored in their systems, to re-appear as instinct and intelligence in the offspring.

Sometimes the most affluent families come to want, and perfect females are dwarfed in their reproductive organs by scarcity of food and are only capable of being helpers.

From all this diversity there is at last a type evolved which is on the whole the best for the majority of the bees. This type is one involving a degree of imperfection in the reproductive organs of all offspring unless highly stimulating food in large quantity is supplied from a very early stage of growth. Thus the normal product is simply a helper and the number of males and females in proportion to the number of helpers and the food supply is a matter entirely under the control, not of chance nor of the mother, but of the community. This then, I think, is the foundation of the Hive-Bee family, the highest type of the flying Hymenoptera.

As instinct enlarges and intelligence increases, the helpers take more and more upon themselves the care of the household. They become pre-eminently the workers, and their officious interference is continually stopping the mother-bee's toil, and stuffing her with the best food they can obtain. She gives herself up more and more exclusively to the work of reproduction, and her powers increase till she becomes capable of changing food into eggs and individually starting a hundred thousand existences in her single lifetime.

Between this highest type of the bee and the lowest, we find several hundred varieties all capable of explanation, either as progressive or retrogressive developments from our primitive bee. Many of them are highly specialised in their social habits, and it seems to me that all those that have two fully developed sexes and one or more undeveloped sexes, must necessarily have

[1] Lubbock's instances of ants attacking strangers and not rescuing friends by no means demonstrates the opposite of this proposition.

thrift, intelligence and filial love as the foundation without which it is impossible that such creatures should of themselves build up such a singular condition.

It seems to me that hunger, something approaching starvation, is necessary as a beginning of the specialisation. Now we all know that from their capacity to increase with enormous rapidity some insects are subject to great vicissitudes in the matter of food. The locusts, for instance, increase in numbers till, having eaten everything in their native habitat, they leave it in dense masses that obscure the heavens and which devastate vast regions. Of the next brood, immensely more vast in numbers than even these, comparatively a small remnant reach maturity, and scarcely any reproduce their kind. The race grows up again from the few starved individuals too weak to leave the old habitat and of which a few manage to survive long enough to lay some eggs. Those doubtless produce many imperfect insects, but these specialisations are not useful to the race in this case, and they cannot survive. I think it likely, however, that man could specialise locusts and many other insects in this way without difficulty. I think it likely that he could with great care so specialise fish and possibly fowls and with great patience and much difficulty some of the mammals. I think also that if mules were from a thrifty hoarding stock like squirrels they would be in the habit of feeding the old mare as the workers feed the mother-bee. But while it may be allowable to mention these as interesting possibilities I do not propose to discuss them in this paper.

There is another element which is, I think, very important in fixing the definite type of the workers, and which I had intended to discuss. But while I think that element important in the bee and perhaps absolutely necessary for the still higher specialisation of the ant, I think also that a permanent body of workers is necessarily evolved from the conditions which I have assumed as natural and proper to the primitive bee.

To recapitulate in few words:

I presuppose a primitive bee fertile and affectionate, hoarding and intelligent.

I show that great want will necessarily diminish the number of her eggs.

That it will render some eggs imperfect by deranging the reproductive organs of the mother.

That consequently some of the offspring will be defective in the reproducing organs.

That while other imperfect bees will generally die before maturity, those imperfect only in the reproductive organs will live if the perfect offspring live.

That some of these being incapable of mating, will not go away for that purpose, but will stay with the mother-bee.

That, having surplus energy to expend, they will use it in accordance with the instinct of the race in gathering and storing food.

That the surplus food will be utilised by the mother-bee, and that therefore this family will be affluent.

That, being affluent, the formerly overtaxed mother will recover her health, and that her offspring will thereafter be perfect.

That consequently these nursemaid-bees will have no successors, and the family will therefore be again reduced to want.

That some bees of the same hatch with the nursemaids will be congenitally imperfect, notwithstanding that they leave the mother and find mates.

That the offspring of congenitally imperfect bees will be extremely variable.

That some of this offspring will be unable to reproduce and that they will remain with the mother-bee as nursemaids or helpers.

That these helpers from the congenital imperfections of their mothers will have successors; substantially as is seen among the hive-bees and the humble-bees of the present day, and

That the variation thus started will eventually be reduced to a definity type or to definite types—by the survival of the fittest.

That whatever other circumstances may aid in producing the result in question, this is sufficient of itself to account for the specialisation of the bee and the ant into females, males and workers.

SCIENCE IN FRENCH COCHIN CHINA

WE have already referred to an official publication of the French Colonial Government in Saigon, entitled *Excursions et Reconnaissances*, which appears every two months, and is wholly devoted to recording the investigations made by French officials in French Cochin China and the neighbouring semi-independent and independent States. The course and results of the numerous scientific missions despatched to these regions by the Ministers of Education and the Colonies, as well as the travels and researches of private individuals, are published in this periodical; and as there are six numbers published annually, of about 200 large octavo pages each, it will readily be perceived, apart altogether from the dearth of information, other than political, with regard to the great Indo-Chinese peninsula, that these volumes form a mine of knowledge of the most authentic and trustworthy description, for the writers are for the most part men who have been specially selected in France to study the subjects with which they deal. Unfortunately, however, the publication is but little known in this country, no copy being obtainable in some of our largest official libraries. As it is on sale in Saigon, and doubtless also in Paris, there is no reason why a periodical so valuable should not be made accessible to English students.

We have before us the three last numbers, and from them it is possible to obtain an idea of the scientific work which the French are performing in their new possessions. No department of research escapes their attention, and they are indefatigable in studying the country and people for whose welfare they have now become responsible. In one respect these volumes resemble those of many learned societies in India and elsewhere: they are extremely varied in their contents. Shafts have been driven in all directions, and the result is here; but when we recollect the short period that the French have been even at Saigon, the still shorter period that they have been able to travel in the interior, it will be apparent that no merely private society could accomplish the work done here. The traveller in most parts of Cochin China still requires a guard of twenty or thirty *tirailleurs*, which can only be provided by the Government. Again, few private persons, however enthusiastic, could afford to spend several years travelling over every part of Cochin China in search of ancient inscriptions, as M. Aymonier has done. Such work as this could, under the circumstances, only be performed with the assistance of Government; and it is greatly to the credit of the French Government that amongst its responsibilities in connection with colonies in the East, it recognises that of thoroughly investigating in a scientific manner the people and territories around them. It has often been said that the French are more sympathetic rulers of subject races than the English, and that they succeed sooner in gaining their affection; whether this be true or not, it is certain that they go the right way to rule properly, by setting themselves at the outset to comprehend what manner of people and of country it is that they are called upon to rule. Science, at any rate, gains by the French practice a consideration which is not very often present to the minds of our colonial rulers.

Geography naturally plays a considerable part in the *Excursions et Reconnaissances*, for a great part of Cochin China is still a *terra incognita*. For a like reason there is much that is specially ethnological. Thus, in the numbers before us we have two papers on the Moïs tribes: one by M. Nouet, recounting a journey amongst the Moïs on the north-eastern frontier; the other, by M. Humann, on the independent Moïs. In the first these curious people are described as slothful and careless, knowing nothing of money, wandering about from place to place in search of subsistence, without any industry beyond producing articles which are absolutely necessary, and always hungry. They are excessively timid, flying into the forest on the approach of a stranger; they have no writing, and appear to have no religion either; they bury and burn the dead, but there are no subsequent ceremonies in connection with the departed. Even those within French territory lead a savage life; their existence is described as, not dying of hunger, rather than positive living. But the race is disappearing slowly from misery and disease; the prohibition against burning the forests is said to bear hardly on them, as it is the only method they know for clearing patches for the cultivation of their rice. The independent tribes, described by M. Humann, are braver than those which are found further south; they can work in iron, and appear more provident and less nomadic. But they live amongst the mountains, whither they have fled before the Annamites on one side and the Siamese on the other.

Dr. Tirant contributes a very long paper, extending over the last three numbers, on the reptiles of Cochin China and Cambodia. It does not profess to be complete, for an exhaustive study of the subject would require collections and books not to be obtained at Saigon. That it must be tolerably full, however, appears from the list of serpents, of which there are 87 in all, 17 being poisonous, the rest harmless. The scientific name, the Annamite and Cambodian names, are given in each case.

The inscriptions scattered all over Cambodia, which, like the great ruins of Angkor, have come down from an earlier civilisation which has otherwise disappeared, have attracted much attention, and have now apparently reached a stage in which scholars are violently quarrelling about them. Papers on them, generally accompanied by copies of the inscriptions, appear in every number of the periodical. M. Aymonier was specially sent out from France to study them, and in less than three years he succeeded in obtaining a *corpus* of about 350 inscriptions. These are in many languages, the principal, however, being in Khmer, or ancient Cambodian; and their examination has thrown much light on the history of Cambodia in ancient times, and possibly on the ethnological problems of the Indo-Chinese peninsula. The general result of the investigation so far, represents the distribution of the inhabitants of the southern part of the peninsula in the first centuries of the Christian era as follows:—The Annamites were still confined to Tonquin, while the Chams occupied the coast of the present Annam; tribes more or less numerous called Chongs, Kouis, Samre, &c., occupied the present Cambodia and Southern Laos. Probably their social state was more advanced than that of the tribes still existing between the valley of the Meikong and the coast of Annam. The Laotian people spread along the valley of the Meikong from Luang Prabang in Siam to Lokhon, while the Siamese were scattered about in principalities in the centre of the country now occupied by them. There existed a primitive religion amongst all these tribes: in April they rendered homage to the spirits of the high places, and in October they offered of the fruits of the earth to the *manes* of their ancestors. They knew of the use of iron and made arms and tools for themselves, and they cultivated rice. Then came Indian traders, who penetrated by the Meikong River, founded small colonies, and reduced some of the natives to slavery. They established independent states, and from them we get the name Cambodia, originally a title of honour. Thus the present population of Cochin China is the result of two totally distinct races and civilisations—Indian and the aboriginal native. The inscriptions give the history of the Khmer dynasty down to the twelfth century.

M. Landes writes on the folk-lore of the Annamites, while M. Aymonier has another long paper entitled "Notes on the Laos," being a series of observations made during journeys in the Laos country, which he has not been able to work up into a connected paper on this curious people. They embrace every conceivable subject relating to the Laos: the geography of the country, their ethnological features, customs, rites. There are up to the last issue seventy-nine of these notes, referring to as many different points connected with these tribes.

A lengthy report by Dr. Burck, Director of the Botanical Garden at Buitenzorg, in Java, is printed. It contains an account of his exploration in the highlands behind Padang, on the west coast of Sumatra, in search of the trees which produce guttapercha. The present state of the subject is this: Specimens of guttapercha are found in considerable quantities in trade, but it is impossible with our present knowledge to determine the botanical origin of a single one of these specimens. The *Dichopsis gutta* (Benth.), the *Isonandra gutta* of Hooker, is the only species of tree producing guttapercha of which botanical specimens have been sent to Europe. But it has never been exactly and completely described, for no man of science has seen the fruit or seeds in their maturity. No one can at present affirm with certainty the origin of such or such a kind of guttapercha in trade. Dr. Burck maintains that the tree has never been found at Singapore and that since the disappearance of the forests there no one can affirm that the *Dichopsis gutta* can be found in its wild state. The paper is of considerable length and the writer disputes certain statements in the Kew reports with reference to the trees producing guttapercha and the places where they are found. An account of a journey in Siam and a translation of a long Tonquinese poem with copious explanatory notes and an excursus on Annamite literature are the remaining papers of these three numbers, the product of six months' work. At this rate the eastern part of the Indo-Chinese peninsula cannot long remain unknown to Europe.

Since the above was in type we have received the succeeding number (vol. ix. No. 22) of the periodical here referred to. It contains a report from M. Aymonier on a further journey of his in search of inscriptions, and describing in some detail the tribe of Chams in Cambodia. He promises a complete work later on this tribe in the province of Binthuan, which have been almost wholly unknown hitherto. The same writer concludes his valuable notes on the Laos, the present instalment dealing with the Kouis, the Khmers, and the province of Korat. These notes occupy more than half the whole number, and, in the present state of our knowledge of the Laos tribes, are simply invaluable, supplying as they do the results of long and close observation on the part of the only European traveller who has yet had an opportunity of living and travelling amongst them. M. Baux has a short encyclopædia sort of article on tea, which is of no especial note. M. Landes continues his folk-lore of Annamites, under the title "Contes et Légendes Annamites." So far he has given fifty popular tales and fables, in which we find many old friends. Androcles and the lion reappear, for example, as the midwife and the tigress, the reward being a pig caught by the latter and carried as a present to the woman. Dr. Tirant, having concluded his study of the reptiles, commences in this number a paper on the fishes of Lower Cochin-China and Cambodia. Fishes play here a preponderating zoological *rôle*; Southern Indo-China forms an ichthyological province closely allied with Malayasia; Lower Cochin-China in particular has curious affinities in this respect with Borneo. The present number contains only the first instalment of Dr. Tirant's "Notes," as he modestly styles a paper of great research and investigation.

ON THE MEASUREMENT OF MOVEMENTS OF THE EARTH, WITH REFERENCE TO PROPOSED EARTHQUAKE-OBSERVATIONS ON BEN NEVIS[1]

MEASUREMENTS of earth-movements are of two distinct types. In one type the thing measured is the displacement, or one or more components of the displacement, of a point on the earth's surface. For this purpose the mechanical problem is to obtain a *steady point*, to be used as an origin of reference, and this is effected by making use of the resistance which a mass opposes to any change of motion. This may be called the *Inertia* method of observing earth-movements. It is applicable to ordinary earthquakes, and also to the more minute earth-tremors which would pass unnoticed if instrumental means of detecting their presence were not employed. The steady point is to be obtained by suspending a heavy mass (with one, two, or three degrees of freedom) in such a manner that its equilibrium is very nearly neutral. Any moderately sudden displacement of the ground in the direction in which the mass has freedom to move leaves the mass almost undisturbed, and the displacement of the ground is therefore easily measured or recorded by a suitable autographic arrangement, which must be so designed as to introduce exceedingly little friction.

The second type of measurement is that in which the thing measured is any change in the inclination of the surface of the ground relatively to the vertical. Movements of this class have been examined by d'Abbadie and Plantamour, and also by G. H. and H. Darwin, who have given the results of their observations to the British Association in two reports on the lunar disturbance of gravity (1882-3). Perhaps the most convenient name for these movements is "earth-tiltings." They are measured by what may be called the *Equilibrium* method. A pendulum, suspended in a viscous fluid, is employed to show, by its equilibrium position, the true direction of the vertical, and that is compared with the direction of a line which is fixed relatively to the surface of the ground; or, instead of a pendulum, a dish of mercury or a pair of spirit-levels are employed to define a truly horizontal surface, and the tilting of the earth's surface relatively to that is observed. This method is practicable only when the displacements of the surface have so great a vertical amplitude, in comparison with their horizontal wavelength, that the slope of the wave is sensible; and, further, only when the changes of slope occur slowly enough to put the inertia of the pendulum or fluid out of account.

On the other hand, the inertia method is applicable only when the displacements have so short a period, in comparison with their amplitude, that the acceleration of the ground, during

[1] Paper read before Section A of the British Association at Aberdeen, by Prof. J. A. Ewing, of University College, Dundee. (Abstract.)

the greater part of the motion, is large relatively to the frictional resistance of the suspended mass.

Between ordinary earthquakes and tremors, on the one hand, capable of observation by the inertia method, and slow earth-tiltings, on the other, capable of observation by the equilibrium method, it is at least possible that there may be many movements, not reducible to either type. For example, if successive upheaval and subsidence of small amplitude were to occur with a very long horizontal wave-length, and with a period of (say) one or two minutes or more, it would be practically impossible even to detect its existence by either of the methods named, unless by chance it were repeated several times with uniform period in the presence of a very frictionless vibrator whose free period happened to agree nearly with the period of the disturbance; even then, no measurement of its amount could be made. We are in fact forced to classify earth-movements under the two heads which have been named, not because there is any necessary discontinuity between the two, but because they must be treated by two entirely distinct modes of observation.

For the measurement of palpable earthquakes by the inertia method, the writer has devised many instruments which have been successfully applied to the registration of Japanese earthquakes, and which are described in a memoir on earthquake measurement, published in 1883 by the University of Tokio. He has not attempted in any case to give the astatically suspended mass three degrees of freedom, and nothing would be gained by doing so. An instrument with two degrees of freedom is now exhibited to the Association. It consists of an ordinary pendulum coupled with an inverted pendulum, in such a manner that the two bobs move together in any horizontal direction. This combination of a stable with an unstable mass can be adjusted to give any desired degree of astaticism. In practice it is convenient to allow the joint mass to have a free period of from five to ten seconds, the period of ordinary earthquake waves being much less than this. A long and light lever, pivoted to the frame of the instrument at one point, and to the steady mass at another, forms a registering index, by which a magnified trace of the earth's horizontal movement is deposited on a fixed plate of smoked glass with the least possible friction.

In another instrument two components of horizontal motion are separately determined, each by a horizontal pendulum, tilted slightly forwards to give a small degree of stability, and furnished with a multiplying pointer. In this instrument the pointers trace the successive movements of the earth on a plate of smoked glass which is kept revolving uniformly by clockwork. The velocity and acceleration of the movements are deducible from the records. This is the standard form of seismograph employed by the writer, and, to make the information it gives complete, another instrument for registering (on the same plate) the vertical motion of the ground is added.

The vertical-motion seismograph is a horizontal lever, supported on a horizontal fixed axis, and carrying at one end a heavy mass. A spring attached to a fixed point above holds up the lever by pulling on a point near the fulcrum. To make the mass nearly astatic the point at which the spring's pull is applied is situated below the horizontal line of the lever, so that when the spring, by (say) being lengthened, pulls with more force, the point of application moves nearer the fulcrum, and the moment of the pull remains very nearly equal to the moment of the weight.

Apart from its application to palpable earthquakes the inertia method is to be applied to minute earth-tremors of the kind observed in Italy by Bertelli and Rossi, which are probably to be found wherever, and whenever, one searches for them with sufficient care. But in dealing with them no mechanical means of recording can well be applied, on account of its friction, and a still more frictionless method of suspending the heavy mass is desirable. The writer prefers for this purpose a mode of suspension based on Tchebicheff's approximate straight-line motion; and to detect the movement of the ground he observes, by a microscope fixed rigidly to the frame of the machine, the displacement of the frame with respect to the suspended mass. This is Bertelli's method, except for the substitution of a nearly astatic mass for the stable mass used by him—namely, the bob of a short pendulum—which of course gives a misleading magnification of certain vibrations.

The writer was recently requested by the Directors of the Ben Nevis Observatory to design seismometers for use there, and obtained a Government grant for their construction. The equipment at Ben Nevis will include recording-seismographs, and a micro-seismometer of the kind just described. To measure slow earth-tiltings an instrument is being constructed in which a modification (due to Wolf) of d'Abbadie's arrangement (described in Prof. Darwin's Reports) is followed. Light from a lamp travels some twenty feet horizontally to a mirror inclined at 45° to the horizon. It passes vertically down through a lens which brings the rays into parallelism. They then strike two reflecting surfaces—one the surface of a basin of mercury, the other a plane mirror very rigidly fixed to the rock. The rays come back to form two images near the source, and any relative displacement of the two images is measured by a micrometer-microscope. In the choice and design of this instrument the writer has to acknowledge much assistance from Prof. G. H. Darwin. This apparatus, like the others, was intended for Ben Nevis, but a visit to the Observatory there has convinced the writer that to use it on that site, and in the atmosphere which prevails on the top, would be a matter of extreme difficulty, and that, in the first instance at least, observations should be made with it on lower ground.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. P. G. Tait has been elected an Honorary Fellow of Peterhouse; and Mr. T. T. Jeffery, M.A., a Fellow of the same College.

Mr. J. Larmor, M.A., of St. John's College, has been appointed one of the University Lecturers in Mathematics, and also Examiner for the First Part of the Mathematical Tripos of 1886.

The Syndicate appointed to re-arrange the additional subjects of the Previous Examination have reported in favour of adding Elementary Dynamics to Statics, and reducing the Trigonometry to what is needed for the Examination in Mechanics; Mathematical Honour students, they recommend, shall no longer be required to pass this Examination, but instead be required to pass in either French or German. Physical Science and Biology are still to receive no recognition even as optional subjects.

Dr. Burghardt, Lecturer in Mineralogy in Owens College, Manchester, is appointed to examine in Mineralogy in the Natural Sciences Tripos; Prof. Ray Lankester, F.R.S., to examine in Zoology and Comparative Anatomy in the same Tripos, the First M.B., and the Special Examinations.

Christ's College offers Scholarships and Exhibitions for Natural Science, the Examination beginning January 5, 1886. The Examinations at Jesus College begin on the same day.

The Special Boards for Physics and Chemistry and for Biology and Geology have issued the following notice with regard to the First Part of the Natural Sciences Tripos:—

In Part I. of the Examination all the questions will be of a comparatively elementary character, and will be such as to test a knowledge of principles rather than of details. Specimens may be exhibited for description and determination.

In Physics the questions will be limited to the elementary and fundamental parts of the subject, and, in particular, special attention will be paid to the definition of physical quantities, the general principles of measurement, the configuration and motion of a material system, the laws of motion, the comparison of forces and of masses, and the properties of bodies. In Sound, Light, Heat, Electricity and Magnetism, only the fundamental laws, their simpler applications, and the experiments which illustrate them, will be required.

In Chemistry the questions will relate to the leading principles and experimental laws of Chemistry, the properties of the commoner elements and their principal compounds, the outlines of Metallurgy, and simple qualitative and quantitative analysis.

In Mineralogy the questions will be confined to elementary Crystallography, the general properties of minerals and the special characters of those species only which are of common occurrence or of well-known mineralogical importance.

In Geology the questions will be limited to Physical Geography, the interpretation of the structure of the crust of the earth and the history of its formation, so far as to involve only the elementary parts of Palæontology and Petrography.

In Botany the questions will relate to the elementary parts of Vegetable Morphology, Histology, and Physiology; and to the principles of a natural system of classification as illustrated by the more important British natural orders. Candidates will be required to describe plants in technical language. Questions will not be set on Vegetable Palæontology or the Geographical Distribution of Plants.

In Zoology and Comparative Anatomy minor details will not be included in the questions relating to classification. Geographical distribution of animals is held to be a part of Zoology, and Comparative Anatomy includes the structure of extinct as well as of recent forms.

Human Anatomy will include the mechanism of the human body, the comparison of its parts with those of lower animals, its development, &c.; but the questions will be of a simple and elementary character.

In Physiology the questions will be of a comparatively elementary character.

A practical examination will be held in each of the above subjects.

SCIENTIFIC SERIALS

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft in Zürich, August 7-9, 1883.—We note here the opening address by Prof. Cramer, on unicellular fungi.

Verhandlungen der Naturhistorischen Vereines der preussischen Rheinlande, Westfalens, und der Reg-Bezirks Osndrück, 42nd year, first half, 1885.—The greensand of Aacken and its molluscan fauna, by J. Böhm.—The forest vegetation of the outer North-western Himalaya, by D. Brandis.—On Devonian Aviculaceæ, by O. Follmann.—The biology of water plants, by H. Schenck.

Nouveaux Mémoires de la Société Helvetique des Sciences Naturelles, vol. xxix. part 1, 1884.—Geological sections of the Tunnels of Doubs, by M. Mathay.—On the nisal flora of Switzerland, by M. Heer. Fossil woods from Greenland, by M. Beust.

SOCIETIES AND ACADEMIES

London

Mathematical Society, November 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. L. J. Rogers, Balliol College, Oxford, was elected a member.—The following gentlemen were elected to form the Council for the ensuing Session:—President: J. W. L. Glaisher, F.R.S.; Vice-Presidents: Dr. O. M. Henrici, F.R.S., Prof. Sylvester, F.R.S., J. J. Walker, F.R.S.; Treasurer: A. B. Kempe, F.R.S.; Secretaries: M. Jenkins, R. Tucker; other Members of the Council: Prof. Cayley, F.R.S., Sir J. Cockle, Knt., F.R.S., E. B. Elliott, A. G. Greenhill, J. Hammond, H. Hart, C. Leudesdorf, Capt. P. A. Macmahon, R.A., Samuel Roberts, F.R.S.—The following communications were made:—On waves propagated along the plane surface of an elastic solid, by Lord Rayleigh, F.R.S.—On the application of Clifford's graphs to ordinary binary quantics, by A. B. Kempe, F.R.S. (Messrs. Hammond and Macmahon put questions to the author).—On Clifford's theory of graphs, by A. Buchheim.—On unicursal curves, by R. A. Roberts.—On some consequences of the transformation formula $y = \sin(L + A + B + C + . -)$, by J. Griffiths.

Linnean Society, November 5.—Sir John Lubbock, Bart., President, in the chair.—Mr. T. Christy exhibited orchids of the genus *Catasetum*, showing that owing to the plants having been moved, the flower in both instances had become malformed.—Mr. E. A. Heath showed a golden eagle in its characteristic plumage of the second year.—Mr. J. Carter exhibited a collection of seeds, lately introduced, remarkable for their peculiarities as specimens under the microscope.—There was shown for the Baron von Mueller a collection of skeleton leaves of species of *Eucalyptus*, prepared by Mrs. Lewellin of Melbourne. These confirm Baron von Mueller's observations as to definite layers, and the relation of these to the skeletonising process. The leaves in decaying produce no bad odour. Von Mueller's observations do not support M. Rivière's statement that the bamboo is as good as eucalypts to subdue malaria; the former dry up, but do not exhale volatile oil as do the latter, and the eucalypts moreover absorb moisture as quickly as Willows, Poplars, and Bamboos.—Dr. Ondaatje showed examples of walking-sticks from Ceylon palms, viz. the Kittool Palm (*Cayota urens*), the Areca and Cocoa-nut.—Mr. J. G. Baker made remarks on an exhibition by Mr. Thiselton Dyer of Darwin's potato (*Solanum maglia*), grown at Kew, the weight of twelve tubers being 28 oz.; also the "papa de Oso," Bear's potato (*S. tuberosum*, var.), grown out of doors from tubers received from Dr. Ernst of Caracas, who obtained them from Merida, where they are found wild.—Then followed a paper, viz. contributions to the flora of the Peruvian Andes, with remarks on the history and origin of the Andean flora, by Mr. John Ball. In this paper the author says that his statements chiefly refer to the western slope of the Cordilleras. From the collections made and other data, so far, therefore, a this region of Peru is concerned, it may confidently be averre that the limit of Alpine vegetation has been placed by previous writers on the subject far too low. In the present instance there can be no serious error as to heights, seeing these are based on those of the railway engineers. The explanation of this relatively high extension of the temperate flora depends on the peculiar climatical conditions. Rain occurs but sparingly, the nights are cold, but frost scarcely known; whereas in the plateau region eastward storms, heavy snow, and frosts are frequent. The vegetation of the region visited Mr. Ball divides into a sub-tropical dry zone from coast to 8000 feet, a temperate zone reaching to 12,500 feet, and an Alpine zone upwards to 17,000 feet, above the sea-level. As regards the proportion in which the natural families of plants are represented in the Andean flora, the Compositæ amount to nearly one-fourth of the whole species, the grasses equal one-eighth, the Scrophularineæ supply five per cent., while Cruciferæ, Caryophylleæ, and Leguminosæ each are represented by about one-thirtieth of the whole. The Cyperaceæ are conspicuous by their absence; a remarkable feature is the presence of four Crassulaceæ. If we take the proportions of the endemic genera and species as criteria, then, as far as materials admit, the Andean flora appears to be one of the most distinct existing in the world. Mr. Ball agrees with those who think it probable that the south polar lands constitute a great archipelago of islands. To this region in question he is inclined to refer the origin of the Antarctic types of the South American flora.—The first part of an exhaustive monograph on recent Brachiopoda, by the late Dr. Thos. Davidson, was read by the Secretary. In this part of his contribution the author reviews the labours of his predecessors in the field, with regard to the shell, to the anatomy of the adult, and to the embryology. As regards the perplexing question of affinities he remarks:—"Now, although I do not admit the Brachiopoda to be worms, they may, as well as the Mollusca and some other groups of invertebrates, have originally diverged from an ancestral vermiform stem, such as the remarkable worm-like mollusk *Neomenia* would denote." He lays stress on the brachiopodous individual being the product of a single ovum, and not giving rise to others by gemmation. He considers that the shell, the pallial lobes, the intestine, the nerves, and the atrial system, afford characters amply sufficient to define the class. The greatest depth at which a living species has been found alive has been 2990 fathoms. As to classification, he groups the recent species into two great divisions:—(1) Anthropomata (Owen) = Clistenterata (King), (2) Lypomata (Owen) = Tretenterata (King). The Anthropomata he groups in 3 families:—1st Fam. Terebratulaceæ, with 7 sub-families and 13 genera and sub-genera, 70 species, and 21 uncertain species. 2nd Fam. Thecideidæ, with 1 genus and 2 species. 3rd Fam. Rhynchonellidæ, 1 genus, 1 sub-genus, and 8 species. The Lypomata he also groups into 3 families, 5 genera and sub-genera, 23 species, and 7 uncertain species:—1st Fam. Craniidæ, with 1 genus and 4 species. 2nd Fam. Discinidæ, with 1 genus, 1 sub-genus, and 8 species. 3rd Fam. Lingulidæ, with 1 genus and 1 sub-genus, and 11 species. He does not concur with M. Delongchamps' scheme (1884) of classifying the Terebratulina, bringing forward Mr. Dall's observations on *Waldheimia floridana*, of delicate spiculæ in the floor of the great sinuses as telling evidence against the arrangement. Dr. Davidson then proceeds to treat of the various genera and species, adding remarks in detail on the Terebratulaceæ from his standpoint, and throughout gives copious descriptions and observations on each.

Royal Microscopical Society, October 14.—The Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Crisp exhibited D'Arsonval's water microscope, a suggestion for improving the means of focusing. The body-tube of this extraordinary instrument contained a glass cylinder which was connected by an india-rubber tube with a syringe. On turning the handle of the syringe water was forced into the cylinder, and the focus was altered according as more or less water was pumped in. Of course, an alteration of focus did result from the operation, but the arrangement destroyed the correction of the objective, and was otherwise objectionable.—Mr. J. Mayall, jun., described Riddell's binocular microscope, which was exhibited by Mr. Crisp, and was of considerable interest, as having been the first binocular microscope with a single objective. He pointed out as a noteworthy feature that it was provided with a means of separating the prisms, so as to give to each eye-piece a full field of view. There was also a screw with a right- and left-handed thread for separating the tubes to suit the width between the observer's eyes. An ingenious application of reflectors at the top of the eye-pieces effected a perfect inversion of the image, so that the instrument could be used for dissecting purposes. It was also a point of special interest in the history of the development of the binocular microscope, that so early as this Prof. Riddell had applied two mirrors for the purpose of equalising the illumination in both fields.—Mr. Crisp exhibited a "twin" simple microscope having two lenses of different powers, also two forms of magnifiers sent by Mr. Hippisley as examples of the capabilities of lenses made out of spherules of glass, and of a simple method of holding them.—Dr. Maddox read his paper, further experiments on feeding insects with the curved or "comma" bacillus.—Mr. Crisp said they had received six slides of material taken from the intestines of Lieut. Kisslingbury, U.S.N., one of the victims of the unfortunate Greeley Arctic Expedition. When the question of cannibalism was being discussed, his body was exhumed, and a good deal of the flesh was found to have been cut off the bones. In order to ascertain if possible what was the last food of which the deceased had partaken, and to establish whether the officers had joined in the cannibalism of the men, the contents of the stomach were submitted for examination. The letter of Mr. C. E. Alling, accompanying the slides (which were sent by Dr. Mandeville and himself) was read to the meeting. Mr. Groves said that although it might be possible to say, from an examination of these slides, whether the material consisted of the flesh of a mammal, a bird, or a fish, it would be quite impossible to say if it was human flesh or not, unless it happened that some hair had been taken with it. Mr. Crisp said that this opinion was confirmed by Prof. Stewart of the Royal College of Surgeons, who, however, thought that a means of identification might be found in the small hairs of the general surface of the body. The slides, however, showed no such hairs.—Mr. P. D. Penhallow's note as to a handle for cover-glasses was read.—Mr. C. Beck exhibited a compact form of Mr. Stephenson's catadioptric illuminator.—Mr. Kitton's and Mr. Kain's notes on balsam of Tolu were read, and Mr. Kitton's note on a new diatom, *Navicula Durrandii*.—Mr. J. C. Stodder's note was read, giving the views held by the late R. B. Tolles on the formation of a small battery of objectives to cover reasonably well all the requirements of the general microscopist: 3 in., 1 in. (30°), 4-10 in. (110° dry), 1-10 in. (oil-glycerin-water immersion with a balsam angle of not much less than 120° for best results).—Mr. C. D. Ahrens' paper on an improved form of Stephenson's erecting and binocular prisms was read, in which he proposed to unite the lower prisms by a wedge of glass. He also proposed an alteration in the upper prisms (when they are used in place of a plate of glass).—Mr. T. B. Rosseter's paper on the uses and construction of the gizzard of the larva of *Corethra plumicornis* was read by Prof. Bell, and prepared specimens in illustration exhibited.—Mr. Dowdeswell's paper on the cholera comma-bacillus was read.—The President called the attention of the meeting to the death of Mr. Robin, the eminent histologist, and one of the Honorary Fellows of the Society.—Seventeen new Fellows were elected and proposed.

Paris

Academy of Sciences, November 9.—M. Jurien de la Gravière in the chair.—Determination of the mechanical work effected in human locomotion (one illustration), by MM. Marey and Demeny. This is an attempt to estimate the quantity of muscular energy developed by man in the various forms of locomotion from the physiological standpoint, which is shown to be different from the mechanical. Three chief elements in the measurement of muscular action in horizontal movement are here considered separately: The labour expended along the vertical; the labour expended along the horizontal; and the labour required for the oscillation of the lower member during its suspension.—Variations in the mechanical labour expended in the different attitudes of man during locomotion (three illustrations), by the same authors. The estimates here recorded are the results of experiments made on two persons only, walking and running on the level. The experiments will require to be repeated on a large number of subjects in order to determine the influence of weight, height, slope of the ground, and thus arrive at a mean average.—On the radicular nature of the stolons of Nephrolepis: a reply to M. P. Lachmann, by M. A. Trécul.—On the derivation of the solutions in the theory of the Cremona transformations, by M. de Jonquières.—Note on the combe of Péguère, near the thermal station of Cauterets, Pyrenees, by M. Demontzey. The destructive landslips to which this upland valley has long been subject, are shown to be due to denudation and erosive action, hence may be prevented by gradually restoring the vegetation along the steep slopes of the surrounding mountains.—Experimental researches tending to show that the muscles affected by *rigor mortis* remain endowed with vitality till the appearance of putrefaction, by M. Brown-Séquard. Experiments made on dogs some days after being killed seem to render it probable that muscular rigidity is not a state of absolute death, but a transition from life to death, a transition which may last for weeks.—On the action of a mixture of sulphate of copper and lime on the mildew of the vine, by MM. Millardet and U. Gayon.—Analytical theory of the movements of Jupiter's satellites, second part: Reduction of the formulas to numbers, by M. C. Souillart.—An undated letter of the Countess de Lafayette (reign of Louis XIV.) addressed to Segrais, and inviting him to witness "the experiment with an artificial fire giving warmth the whole day for two sous," by M. Feuillet de Couches.—Application of M. Lœwy's new methods for the determination of the absolute co-ordinates of the circumpolar stars without the necessity of ascertaining the instrumental constants (right ascensions), by M. Henri Renan.—On the numerical tables intended to facilitate the transformations of co-ordinates in astronomical calculations, by M. Vinot.—On the irregular integrals of linear equations, by M. H. Poincaré.—Note on the compressibility of fluids, by M. E. Sarrau. The formula—

$$p = \frac{R\,T}{v - a} - \frac{K}{T(v + \beta)^2}$$

proposed by M. Clausius for carbonic acid, in which p = the pressure, v = volume, and T = absolute temperature, is shown to be applicable to other gases. The author claims that for these gases he had deduced the elements approaching the critical point before the experiments of MM. Wroblewski and Olszewski.—On two new kinds of radiophones, by M. E. Mercadier. With these instruments, which he names the "thermo-electrophone" and the "thermo-magnetophone," the author thinks it will be possible, with an intense solar radiation, to reproduce articulate speech.—An explanation of the anomalous magnetic effects produced by the discharges of condensers, by M. Ch. Claverie.—Note on Schlœsing's law respecting the solubility of the carbonate of lime by carbonic acid, by M. R. Engel.—On a coloured reaction of rhodium, by M. Eugène Demarçay. Certain blue solutions of rhodium yield with potassa a greenish precipitate, which changes to a dark blue in acetic acid. This colouration appears due to the formation of a salt corresponding to the green hydrate of bioxide of rhodium.—On the antiseptic and other properties of rosolene (retinol, $C_{32}H_{16}$), by M. Emile Serraut.—On the root of *Danais fragrans*, Comm. (yellow liane) and its chemical composition, by MM. Edouard Heckel and Fr. Schlagdenhauffen.—On the composition and fermentation of interverted sugar, by M. Em. Bourquelot.—On the hypnotic properties of phenylmethylacetone (acetophenone), by MM. Dujardin-Beaumetz and G. Bardet.—On the nervous system of Phylloxera, by M. Victor Lemoine.—On the Limaciæ of the neighbourhood of Saint-Vaast la Hougue, department of La Manche, by M. S. Jourdain.—Variations in the respiration of plants at the different stages of development, by MM. G. Bonnier and L. Mangin.—On a rare amygdaloid granite from the Riaillé Quarry, Saint-Hilaire de Loulay, Vendée, by M. Stanislas Meunier.—On some fragments of human skulls and a potsherd found in immediate association with two skeletons of *Ursus spelæus* in the Nabrigas Cave, Lozère, on August 28, 1885, by MM. E. A. Martel and L. de Launay. The discovery of these remains seems to place beyond doubt the existence of man already possessing a knowledge of the potter's art at the epoch of the Cave bear in the Lozère district.—On the relation of whirlwinds and waterspouts to cyclones, by M. Ad. Nicolas.—Remarks on M. Jourdy's "Geology of East Tonkin," by M. Albert Gaudry.

BERLIN

Meteorological Society, October 13.—The President, Geheimrath Dr. Thiel, reported that, in accordance with a resolution passed by the Society in furtherance of the establishment of a thickly planted series of rain-stations, rain-gauges had been set up at seven places in the outskirts of Berlin to the north-west and west, and since July had been working well. It was to be hoped that their number would soon be increased and that a lengthened series of observations would yield data for an exact determination of how closely rain-gauges must be placed to each other, in order to obtain a correct representation of the rainfall of any district.—Dr. Hellmann then, after a brief historic survey of the institution of meteorological stations at high points, gave a full description of the meteorological observatory at Ben Nevis in Scotland, which he had visited in August last. The topographical situation of the station, the construction and position of the instruments, and the mode of observation were set forth, while some of the climatic peculiarities of this station, such as its great humidity, its small yearly and daily variations of temperature, its scanty sunshine, the frequent reversal of the change of temperature with the height, and other particulars, were also remarked on. Following up the minute description of this important high station in Scotland Dr. Hellmann enumerated all the stations on the peaks of mountains that had hitherto been erected, which comprised only the Puy de Dôme and Pic du Midi in France, the Säntis in Switzerland, the Schafberg and Hochobir in Austria, the Schneekoppe and Brocken in Prussia, and Mount Washington and Pike's Peak in the United States of America. Of these stations only the two French, the Swiss, and the Austrian were of the first rank, or between the first and second rank. In addition to these stations on mountain tops there was a whole series of high situated meteorological stations on mountain passes and plateaus in operation, which collected valuable material towards the meteorology of the higher atmospheric strata, in Italy, Switzerland, Germany, India, South America. In the case even of a temporary residence at high situated points brief but very valuable series of observations had been gained—at Ararat, for example. It must, nevertheless, be the endeavour of scientific meteorology to increase the number of mountain-top stations of the first rank, and the speaker expressed the hope that under the contemplated reorganisation of the meteorological service in Germany, and particularly in Prussia, at least one mountain-top station of the first rank, namely, on the Schneekoppe, which was very peculiarly adapted for this purpose, would be established. In the discussion which followed it was maintained on one hand that self-registering instruments at high stations were perfectly useless, and on the other hand that even tourists, many of whom every summer reached heights beyond 4000 metres high, might, by means of portable pocket instruments, supply contributions quite available towards the meteorology of the higher strata. A member of the Society gave some proofs to this effect, and mentioned the remarkable fact that the red-brown ring round the sun, which he had everywhere seen distinctly, appeared from Monte Rosa, not red-brown, but very distinctly reddish-yellow.—Dr. Börsch related that during a determination of longitude between Berlin, Breslau, and Königsberg, the observer in Berlin on August 2 was sensible of such lively disturbances of his level that he was obliged to discontinue for a time the use of the transit instrument, and considered the oscillations to be seismic. When he afterwards read in the newspapers of violent earthquakes in the interior of Asia having happened at the same time, he made inquiry of the observers at Breslau and Königsberg, and learnt that they too had been disturbed by lively oscillations of the ground. These vibrations had been all the stronger the more to the east was the station, a circumstance which likewise pointed to a connection with the earthquakes of the interior of Asia. More careful observation of such phenomena would render possible the exact measurement of the propagation of earth-vibrations.

VIENNA

Imperial Academy of Sciences, July 2.—Researches on the structure of striped muscles, by A. Rolett.—Contributions to general nerve and muscle physiology (eighteenth communication), on inhibitory effects produced by electrical stimulation of striped muscles and on positive cathodic polarisation, by W. Biedermann.—On pyroracemic glycide ethers, by F. Erhart.—Contributions to the theory of respiratory innervation (fifth communication), by Ph. Knoll.—Studies on the endosperm of some Gramineæ, by E. Tangl.—On a new hydrodensimeter, by A. Handl.—On the nutrition of ganglion cells, by A. Adamkiewicz.—On cyanhydrines of nitroso-compounds, by E. Lippmann.—Contribution to the knowledge of dichinolins, by O. W. Fischer.—On benzoyl-ecgonine and on its transformation to cocaine, by Zd. H. Skraup.—Statistics of earthquakes from 1865 to 1885, by W. C. Fuchs.—Contribution to the morphology and anatomy of the Coccida, by E. Witlacil.—On the Lower Eocene formation of the Northern Alps and on its fauna (Part I. Lamellibranchiatæ), by K. F. Frauscher.—On para-chloraldehyde, by C. Natterer.—On the action of phenol and sulphuric acid on hippuric acid, by T. Zehenter.—On the gum-ferment, a new diastatic enzyma, by which the formation of gum and mucilage in the plants is induced, by E. Wiesner.

July 16.—Note on the meteorites of Angra dos Rais (Brazil), by G. Tschermak.—A contribution to the theory of the mechanics of explosion, by E. Mach and T. Wentzl.—On the anatomy of Tyroglyphidæ, by A. Nalepa.—Contributions to the theory of respiratory innervation (sixth communication), by Th. Knoll.—On the products of decomposition formed by the action of hydrochloric acid on albumins; II. on elastin, by T. Horbaczewski.—Researches on the cloacal epithelium of Plagiostomata, by T. H. List.—On chloro- and bromo-derivatives of phloroglucin, by R. Benedict and K. Hazura.—On the action of potassium cyanide on dinitro-derivatives of organic bases, by E. Lippmann and F. Fleissner.—Note on hydrobromo-apoquinine, by P. Julius.—On the action of ammonia on anthragallol, by G. von Georgevics.—On the behaviour of liquid atmospheric air, by T. Wroblewski.—On ethylsulphuric acids of some carbohydrates, by M. Hœnig and St. Schubert.—Contribution to chemistry of cerium-metals, by B. Brauner.—On the elements and ephemeris of Barnard's (Nashville) comet (July 7, 1885), by E. Weiss.—On the meteoric fall observed on March 15, 1885, by E. Holletschek.—Studies on pyridine-derivatives, by H. Weidel and F. Blau.—On the electric and thermic properties of salt-solutions, by James Moser.—On the formation of striped fibres from sarcoplasts, by T. Paneth.

CONTENTS

THURSDAY, NOVEMBER 26, 1885

THE WHOLE DUTY OF A CHEMIST

ON the 6th instant there was a meeting at the rooms of the Chemical Society in the afternoon, and a dinner in the evening, to celebrate the grant of a Royal Charter to an Institute of Chemistry.

The stated object of the Institute is to do for chemists what has been done for the members of different professions and trades by such bodies as the College of Physicians, the College of Surgeons, the old Guilds, and the modern Trades Unions.

This is possibly a very desirable thing to do, but to the student of pure science the creation of the new corporation possesses no other interest than that which results from the consideration of its prospective influence on the progress of science. Indeed the intention is so entirely commercial that we should not have referred to the new body at any length in these columns if the President, Prof. Odling, in an address delivered on the occasion, had not enunciated views which we believe all true men of science will read with pain, and against which we feel it our bounden duty to make a protest.

Before we proceed to deal with the address itself, it will be well to clear the ground by a few general considerations touching the applications of science to industry, and the manner in which, time out of mind, and we hope for all future time, scientific principles have been and will be brought down to be utilised in the ordinary affairs of life. First of all, it will be readily conceded that in the present state of civilisation there is scarcely any handicraft or manufacture or process in which some scientific fact or principle does not lie at the root of the matter. Our boots are the results of scientific applications, our clothes are the result of scientific applications, the materials depend upon science, the fit depends upon science. If one had to define offhand the difference between a profession and a trade requiring skill in making certain articles, one would say that the profession required more science than the trade, that is, there is not a difference of quality, but of quantity. The bootmaker that makes a boot, and the surgeon that cuts off a toe, both deal, if they do their work well, with the anatomy of the foot, but we expect the professional surgeon to know more about this anatomy than the shoemaker. Further, any science in the process of the amalgamation of its applications with other similar amalgamations at first begins by being in the hands of a few individuals, let us say of high training; it becomes generalised, and then finds itself in the hands of a greater number of individuals probably less highly trained, and so on, till each special application of science becomes the common property of the community.

Au fond, then, so far as science is concerned, we can recognise no distinction between a profession and a trade, or we may use the words an industry, if any one likes them better. These industries or professions once started are kept alive and fostered, and made more useful for mankind, by the perpetual introduction of new scientific facts and processes. This is as true for the improvement in leather and cloth manufactures, as it is in the curing of hydrophobia, which may some day come.

Chemical science, for example, is the very sap of the chemical industries, and there is the most intimate and the most direct connection between the researcher and the manufacturer. A Reichenbach discovers paraffin, and a Young straightway turns it into candles. Andrews demonstrates the true principles of the condensation of gases, and these principles are forthwith applied to the construction of a freezing-machine. The history of technology teems with instances of this kind. Indeed, some of the huge manufacturing concerns of the Continent are driven to anticipate the output of the purely scientific laboratories of the Universities and higher schools by employing investigators for themselves: the great colour-making manufactory at Ludwigshafen has two score of chemists at work on the industrial development of the chemistry of aromatic compounds. Now these investigators are in the first instance made by the Universities; they are the product of their great chemical schools—they are men who have caught something of the spirit of that noble army of teachers who have dedicated their lives to the advancement of natural knowledge for its own sake without thought of guineas or "leading professional position." The growth, then, of the chemical trades must depend ultimately on the help which chemists are able to give to the chemical traders. This help must consist either in new knowledge to be furnished directly by the chemist, or indirectly by the men whom he has so trained that they may know how to seek for it and to find it. Have we not here the true function and real duty of "those of us occupying the leading position in the profession" or "who have already attained the higher steps of the ladder of success," if such men are connected with an University?

The honour given to teachers from the beginning of time was accorded to them not merely for their learning but for the new knowledge they produced and taught. They were the guardians of the sacred fire; and the reverence with which they were regarded depended upon the constancy with which they fed the flame. The estimation in which men of science are held to-day, even if they are not teachers, is due to the national benefits which they confer by giving their lives to learning, teaching, and to writing books for others; and because such men are regarded as the highest benefactors of our race and the founders of our modern civilisation. The nation remembers them even if they often forget themselves.

Such men, however, do not exhaust the number of those who have studied science or who perform useful scientific functions. But the point is, however useful this other class of men may be—like the bootmaker and the tailor, who are eminently useful in their way—their knowledge is merely a stock-in-trade to which they look for their livelihood. We have nothing whatever to say against these men, but it is imperative that we should point out that if their object in life is merely to get money the public estimation of them cannot be expected to be the same as that accorded to those whose lives are devoted to the public good. Is it possible to tell one kind of man from the other?

This can be easily done. Let us assume that he is a professor of science at a well-known seat of learning. Are his lectures the best possible, or does he simply lose the time of his students for so many hours per term?

Is he the life of his laboratory, always there, always setting an example to his students of patient and continuous research? What is the number of researches produced per annum, and what is their value? Do his students revere him or think little of him? Do they give any indications of benefiting by his instruction? Has he founded a school? Has he impregnated his assistants with the love of new knowledge, and do they spend their time in getting it? Or, again, is he the friend of manufacturers, a *grata persona* to limited liability companies? Is he a noted expert in our courts of law? Is he never seen in his laboratory? Is the laboratory now silent, its appliances rotting from disuse, and its old reputation for research become merely the shadow of a shade?

It is really quite easy to find out whether this professor of science is doing his duty or neglecting it; whether the getting of knowledge or the getting of money is foremost in his thoughts.

The dignity of a professor in a seat of learning is closely associated with the dignity and the honour of the seat of learning itself. An University which appoints a man to a professorship places its honour in his keeping so far as his science is concerned. Now the members of an University, even though they may not be especially learned in any particular branch of knowledge, soon know, perhaps even by a kind of instinct, whether a professor is upholding the honour of the *alma mater*, in the welfare of which they are all interested; or whether by forsaking the fair fields of knowledge, and by thinking only of self and pelf, he is dragging her reputation through the mire. This feeling in an University affords another criterion which may be safely relied on if we wish to know whether or not a professor is doing his duty.

Take another case. Let it be that of one who is engaged in commercial matters—whether large or small is immaterial to our argument—into which scientific principles and ideas largely enter; or let us assume him to be engaged, on the strength of his scientific attainments, by a Government department or an industrial body which wishes to utilise his knowledge. Does he expand his routine work into an opportunity of enriching science? Does he make himself the recognised master of a large field of knowledge which he gives to the world? Do his labours confer honour on himself or on the body with which he is connected? Or, on the other hand, is his name never heard at a scientific society? does he merely, in short, content himself with the perfunctory performance of the work by which he makes his money?

We have referred to the dignity of a man of science; what does this mean? The view it expresses is simply the modern view representing that feeling of olden time which made teaching so honourable while trade was despised. Then, as now, the man was often poor, but he spent his life in doing a common good, while the trader was often rich, and dispensed his wares for his own advantage. Nowadays the dignity of a leading man of science is somewhat difficult to define exactly, but the same idea lies at the bottom of it. It is known that he cares more for science than for money. It is known that his whole heart is in his researches; even when they happen to be profitable to himself or to others, he is still not a money-grubber. This dignity is not confined to professors, but a man to possess it must be something more than commercial or professional. We cannot imagine a bootmaker or a tailor on the council of the Royal Society, but yet he employs scientific processes to get his money as much as a chemist does who spends his time in commercial analyses or in courts of law. To come back to our criterion, we think we have indicated that there are various ways in which men of science can be allocated in the two classes to which we have referred.

We now proceed to refer specially, and as briefly as we can, to Prof. Odling's address. It begins with a history of the movement, and then goes on to show the ever-increasing need there is of "professional services" which are rendered by men of various grades, "from those of us occupying the leading positions in the profession, to the most humble individual practising in our ranks." We are dealing, then, with the chemists employed by Government and large corporations, as well as "experts" and analysts; and among these latter not only with the man of "leading position" who charges ten guineas for analysing a sample of water, but with the assistant who actually does the work for the not excessive sum of half-a-crown.

We next read as follows:—

"It would seem, however, from observations not unfrequently hazarded by some very superior persons, whose happy mission it is to put the rest of the world to rights, that there is something derogatory to the man of science in making his science subservient in any way to the requirements of his fellows, and thereby contributory to his own means for the support of himself and of those depending upon him. Now, on this not uncommon cant of the day a little plain speaking would seem to be very much wanted. While the investigation of nature and the interpretation of natural law are admittedly among the highest, as they are among the most delightful, of human occupations, the right application of natural law to effect desirable objects is in itself a scarcely less worthy occupation; many of these objects being of paramount importance, and attainable only by the exercise of high scientific sagacity and skill, aided by a fertility of resource and a persistent elasticity of spirit, ready ever to cope with the successive novel difficulties found to be continually opposing themselves."

On this we have to say—and we shall return to the point further on—that we know of no one who has made the abstract proposition which Prof. Odling condemns. We are prepared to say, however, that in the opinion of many who are not men of science, the appearance of a man of science, occupying a "leading position" as an expert in a court of law, whose "devotion" to his employer causes him to apparently contradict the statements of another man of science on the other side, doubtless equally "devoted," does not add to his dignity. A well-known lawyer, now a judge, once grouped witnesses into three classes; simple liars, damned liars, and experts. He did not mean that the expert uttered things which he knew to be untrue, but that by the emphasis which he laid on certain statements, and by what has been defined as a highly cultivated faculty of evasion, the effect was actually worse than if he had.

It is consoling to think that the qualities most valuable in an expert, since experts there must be, are not those for which men of science are best known. Coolness under cross-examination, verbal dexterity, a ready wit, not too much knowledge or conscience, the fidelity of a partisan, or rather "*professional devotion*," and a dash of impudence, are quite as frequently the passport to the "professional eminence" of an expert as scientific ability.

Surely it is not necessary for us to point out the sophistry and fallacy of the argument that "the right application of natural law to effect desirable objects is in itself a scarcely less worthy occupation" than "the investigation of Nature and the interpretation of natural law," when such applications are made at the instigation of an individual—a client—who pays for such application of natural law at the rate of so many guineas a folio; and who, if it suits him, may then proceed incontinently to suppress "the right application of natural law." Are we to elevate such service as this to a high moral platform, and claim for it the same homage or appreciation which is accorded by the outside world to work done unselfishly and for the benefit of the whole community?

Prof. Odling strengthens his view that we should by the following considerations:—

"In this matter, as in so many others, the sense of proportion is but too often lost sight of. Because the investigations of a Newton, a Darwin, a Dalton, a Joule, and a Faraday have an importance of which few among us can adequately conceive even the measurement; because among the scientific men now or but lately living in our midst are to be found those whose investigations in pure science have not only won for them a high renown, but have earned for them the gratitude, and should have obtained for them the substantial acknowledgments, of their country and the world; and because even the minor investigations and discoveries, placed before the world for the world's use, and not merely to enrich a firm, that are ever being made in pure science have all of them their merit and their value, it does not follow that the mere accomplishment, it may be in an abundant leisure, of two or three minor investigations, however creditably conducted, are to lift their authors into a scientific position altogether above that of men whose laborious lives have been spent in rendering their great scientific attainments directly serviceable to the needs of the State and of the community. The accomplishment of such-like investigations does not entitle their authors to claim exemption from the duty of earning their own livelihoods or give them a claim to be endowed by the contributions of others with the means to jog leisurely along, without responsibilities and without anxieties, the far from thorny paths of their own favourite predilection. However heterodox it may be thought by some, the best of all endowments for research is unquestionably that with which the searcher, relying on his own energies, succeeds in endowing himself. The work to which our natures are repugnant, not less than the work which entrances us and hardly makes itself felt as work at all, has to be done. In some degree or other, we have most of us to obtain our own livelihood; and harsh as may seem the requirement, it will, I suppose, be conceded that the necessity put upon the mass of mankind of having to earn their daily bread is an arrangement of Providence which has on the whole worked fairly well; and, further, that the various arrangements hitherto tried for exempting certain classes of men from the necessity of having to earn their daily bread, in order that they might give themselves up to the higher spiritual or intellectual life, have scarcely, to say the least of them, worked quite so satisfactorily as they were intended to. All of us are, without doubt, qualified for higher things than the mere earning of our daily bread; but the discipline of having to earn our daily bread is, in more ways than one, a very wholesome discipline for the mass of us, and even for the best of us. It may here and there press hardly on particular natures, but it is rarely an impediment to the achievement of the highest things by those having the moral qualities, the judgment, the determination, and the self-denial necessary above everything else for their achievement. Not a few of us may consider ourselves fitted for higher work than the gods provide for us, and fondly imagine what great things we should effect if we could only have our daily bread supplied to us by the exertions and endowments of other less gifted mortals. But experience is not on the whole favourable to the view that, the conditions being provided, the expectation would be realised. Experience, indeed, rather favours the notion that it is primarily the necessity for work, and association with those under a necessity to work,—those in whom a professional spirit has been aroused, and by whom work is held in honour,—that creates and keeps up the taste and the habit of work, whereby the vague ambition to achieve is turned to some productive account. Take, say, a thousand of the most eminent men the world has produced, and making no allowance for the large influence of descent or training, or of association with those to whom work is a necessity, or having been a necessity has become a habit, consider what proportion of these men have, by their means and position in early life, been free from any stimulus or obligation to exert and cultivate their powers; and consider, on the other hand, what proportion of them have been stimulated to exertion and success by the stern necessity of having either to achieve their own careers, or to drop into insignificance, if not indeed into actual or comparative degradation and poverty. We ought, indeed, all of us to be students, and to be above all things students; but the most of us cannot be, nor is it desirable, save in the case of a special few, that we should be only students. We have all our duties to fulfil in this world, and it is not the least of these duties to render ourselves independent of support from others, and able ourselves to afford support to those depending upon us. Fortunate are we in being able to find our means of support in the demand that exists for the applications of a science which has for its cultivators so great a charm. To judge, however, not indeed by their coyness when exposed to the occasional temptation of professional work, but rather by their observations on the career of others, the most sought after and highest in professional repute, the pursuit of professional chemistry is, in the opinion of some among us, a vocation open to the gravest of censure. It is praiseworthy, indeed, for the man of science to contribute to his means of livelihood by the dreary work of conducting examinations in elementary science for all sorts of examining boards, and by teaching elementary science at schools and colleges, and by giving popular expositions of science at public institutions, and by exchanging a minor professorial appointment, affording abundant opportunities for original work, in favour of a more lucrative and exacting appointment involving duties which, if rightly fulfilled, must seriously curtail these same opportunities. It is praiseworthy of him to add to his means by compiling manuals of elementary science, and by writing attractive works on science for the delectation of general readers; but it is, forsooth, derogatory to him, if not indeed a downright prostitution of his science, that he should contribute to his means of livelihood by making his knowledge subservient to the wants of departments, corporations, and individuals, alike of great and small distinction, standing seriously in need of the special scientific services that he is able to render them.

"A glance back suffices to show how foreign to the ideas of the great men who preceded us is this modern notion of any reprehensibility attaching to applied or professional science. In his earlier days, Prof. Faraday was largely employed in connection with all sorts of practical questions, and until almost the close of his life, continued to act as scientific adviser to the Trinity House. No man was more constantly occupied in advising with regard to manufacturing and metallurgic and fiscal questions than Prof. Graham, who ended his days holding the official position of Master of the Mint; a position in which he succeeded another eminent man of science, less known, however, as a chemist than as an astronomer, Sir John Herschel. . . .

"So far, moreover, from his professional eminence and usefulness being made a matter of reproach to the scientific man, it should constitute rightly a claim to his higher consideration; and far from being accounted a disparagement, should be held as an addition to his scientific standing. In the professions most allied to our own on the one side and on the other this is well recognised. The physician and the engineer are not merely students of pathology and of mechanics, however important may have been their contributions to pathology and mechanics respectively, but they are the distinguished craftsmen in their respective arts. And whether or not they may have made important contributions to pure science, their rank as eminent scientific men is everywhere and rightly conceded to them. A lucky chance happening to any professional man may indeed bring him to the front, but no succession of lucky chances can ever happen that will of themselves prove adequate to keeping him there. Great qualities are ever necessary to sustain great professional positions; and to be for years one of the foremost in a scientific profession is of itself at least as substantial an evidence of scientific attainment as is the publication of a memoir on some minute point, say of anatomy, or chemistry, or hydrodynamics, for example. And it is so recognised, and very properly recognised, even in quarters where pure science admittedly reigns supreme. Leading engineers and leading physicians and surgeons are every year admitted into the Royal Society, not on account of the importance attaching to any special contributions they may have made to mechanical or pathological science, but mainly because of their eminence in their several professions, in which to be eminent is of itself an evidence of scientific character and of extensive scientific knowledge. It may indeed be taken as beyond question that to obtain and retain a leading position in a scientific profession, needs among other things the possession of high scientific attainments. I say among other things, for without moral qualities in a notable degree, sympathy, endurance, courage, judgment, and good faith, no such professional success is conceivable. Professional eminence is the expression necessarily of scientific ability, but not of scientific ability alone. The self-engrossing science of the student has to be humanised by its association with the cares and wants, and the disappointments and successes of an outside world."

Having given this long extract from the address, we now proceed to remark on certain parts of it.

In the whole of Prof. Odling's references to the endowment of research, which was so warmly advocated by his predecessor at Oxford, Sir Benjamin Brodie, there is much evidence that he has not even begun to understand the question. No one has ever proposed to endow research for the benefit of the researcher, or to endow researches which are immediately remunerative. The highest needs of the nation and of learning have been alone considered. The idea of endowment was only suggested for the encouragement of such researches as promised no immediate return in the shape of utility, except as pure knowledge. Prof. Odling seems to imagine that if the Fellowships of an University were awarded to men of eminence in science or who had given proof of skill in research, the Fellows would be but charity-boys of larger growth. When Prof. Huxley told the Americans that any country would find it greatly to its profit to spend 100,000 dollars in first finding a Faraday, and then putting him in a position in which he could do the greatest possible amount of work, he was not thinking that Faraday would thus be enabled to give nice dinners, but of the results of that greatest possible amount of work—the new knowledge that would be certain to be garnered and utilised some day for the nation's good. The endowment of research, or aid to research in any form, seems to be so objectionable to the President of the Institute, that the winding up of the Research Fund of the Chemical Society would seem to be one of the most desirable things of the present time, if his opinion is to prevail.

Prof. Odling employs in his argument a well-known method of procedure often used to throw dust in the eyes of a jury. He has put up a bogus case in order to demolish it very much to his own satisfaction. We fear that in this process he has been guilty of much, doubtless unconscious, misrepresentation of many revered names in science. This dummy is the assumed opinion of men of science that a man of science should do nothing to help industry directly. This opinion, as we have before stated, nowhere exists. The opinion does exist, as we have already implied, that such assistance must not interfere with higher work if higher work has been undertaken; and the general consideration of the man of science has risen enormously when it has been known that such aid, when given, has been given openly to all-comers, and not in secret to him who could pay the highest fee. Prof. Odling, in apparent justification of his case, quotes, amongst others, the names of Faraday and Graham, and states roundly that they have done the thing to which the superior persons to whom he refers object. This is untrue; no men were more faithful to their trust than Faraday and Graham, and the proof of our contention lies in the fact that their names are honoured among us while others, their contemporaries, the Ures and Lardners of that day, although men of tremendous "professional eminence," are already forgotten, or live only in the pages of a Thackeray. It has been stated over and over again that such was the fidelity of Faraday to his trust that he refused sums which would have amounted in the aggregate to a large fortune which were offered to him by manufacturers and others to tempt him to neglect his public work for their private advantage. It was a subject of pride to him that he had refused pay for all work he had done for the Government except on one occasion when he accepted it for the sake of a coadjutor. The volumes of Faraday's and of Graham's researches, not to mention those of other honoured names, representing their fidelity to pure investigation during the whole of their working lives, are, after all, the best answers to Prof. Odling, and when we contrast their faithful and long-continued activity in this direction with that of others which began with almost as fair a promise, and then suddenly, before the men were in their prime, was seized by a paralysis or else diverted into other channels, we have an indication, by no means to be despised, of the possible result of merely commercial work.

We believe that some chemists, although they hold the views which we express in this article, have allowed their names to be connected with the new institution, because they think that it may eventually, somehow or other, aid chemical education in this country. We think that this is an error. The College of Physicians has been pointed out as a precedent for the Chemical Institute. Now what has the College of Physicians done for medicine and for medical education? Although it was one of the first founded of the Professional Guilds, we have had repeated occasion to point out in these columns that in the opinion of the most competent authorities, medical education even to-day is the worst organised and least effective.

The latter part of the extract gives Prof. Odling's view as to the easy admission afforded by professional eminence into the Royal Society. As regards engineers, we have never heard of any one being elected into the Royal Society except on the ground of his contributions to science. Commercial or professional eminence has, so far as we know, not been considered. As regards doctors, owing to the ancient ties of the Royal Society with medicine, we believe that it has been the custom to consider, in judging their claims, that marked eminence in their profession should be taken into account; but professional eminence *alone* does not decide the choice. In saying this we do not express our own opinion merely; and we must add that there is no written law in the matter, the decisions each year resting with the Council of that year, and the Council, as is known, is an ever-changing body.

The latter part of Prof. Odling's address, which we have not space to give at length, deals with the advantages which in his opinion are likely to result from the new organisation. He also gives some paragraphs from the preamble of the charter under which the Institute has now been incorporated. One of these paragraphs runs as follows:—"That the said Institute was not established for the purposes of gain, nor do the members thereof derive or seek any pecuniary profits from their membership." We confess we find it difficult to harmonise this extract from the charter with the general drift of the part of the address now under consideration; for although Prof. Odling frankly acknowledges, to quote his words, "to those of us who have already attained the higher steps on the ladder of success it can scarcely afford any personal advantages whatever," it is clear that this is not to obtain universally. Among the "advantages" we find not only "gain to the public" but "gain to ourselves"; we read of "noteworthy advantages, social and material, to the persons" who form the Institute. We also read: "Among its other objects, the Institute of Chemistry exists undoubtedly for the purpose of improving the position and prospects of professional chemists"; we further find that the Institute "will add alike to the social and substantial attractiveness of the chemical profession."

We do not find too many references to researches not of a directly remunerative kind, but Prof. Odling makes one concession: he thinks that among the members of the Institute "some proportion, at any rate, will find the pursuit of research the vocation for which they are especially qualified, and for which they will, IN THE SEED-SOWING TIME OF THEIR LIFE, be willing to make, as others have made before them, even considerable professional sacrifices."

Ilias in nuce. In the phrase we have put into capitals we have the real key to the address. It would appear that the life of a chemist should be divided into two periods—Seed-time and Harvest. Research may be the seed, the harvest must be gold. The continued pursuit of truth, the continued love of science for its own sake, may be left to the unwise. The ideal chemist is one who uses research only as an investment. He carefully limits it to his earliest years. By it he is to gain a reputation as a man of science. His reputation thus gained procures for him a post of high scientific honour and position. The "seed-sowing time" is now over. The golden harvest is ripe. It has to be reaped and garnered. The duties of the position of honour obtained by the original investment are therefore to be thrown to the winds in order that this may be done. He is now a man of "professional eminence": he is now on "the higher steps of the ladder of success."

Does any one think that his electors have a right to protest or his friends to lament? Certainly not; they have no such right. Their feelings have simply arisen from their ignorance of the Whole Duty of a chemical Man.

In these days of rapid intercommunication among nations we know that Prof. Odling's address will be carried to our brethren beyond the seas and to many centres of scientific activity in other lands. We wish it to be known, therefore, that the spirit it breathes is an alien spirit, repugnant to students of pure science in this country.

CENTRAL AMERICAN COLEOPTERA

Biologia Centrali-Americana. Insecta: Coleoptera. Vol. I. Part I. By H. W. Bates. (London: R. H. Porter, 1881-84.)

THIS part of Godman and Salvin's great work is now complete, and though called a part is practically a volume, with introduction, indices, and completed pagination; its publication has extended over four years. It deals with the two great families of carnivorous beetles—the Cicindelidæ and Carabidæ—and consists of 316 pages of letterpress and thirteen plates of coloured figures. The number of species of the two families recorded from the region is 1086, belonging to 154 genera. Nine new genera and about 450 new species are described, this latter figure including, however, a certain number of species characterised for the purposes of this work in the *Proceedings* of the Zoological Society for 1878 and a few others similarly dealt with in the *Annals and Magazine of Natural History.* In his introduction the author touches on some points of geographical distribution, and states that the inclusion of the central highlands of Mexico and Guatemala in the Nearctic province by Wallace is not supported by these insects, but that on the contrary they markedly confirm the essentially Neotropical character of the Central American fauna. He also is inclined to adopt the opinion that the Central American region comprises two distinct sub-provinces, as proposed by Salvin from his study of the birds, the line of division passing probably across Nicaragua; and considers that even the more northern of these sub-provinces is not a southern extension of the Nearctic province, but rather a remarkably distinct sub-province of the Neotropical fauna.

In the body of the work the distribution and extent of each genus is briefly stated, and, so far as known, every locality within the region for each species is recorded; thus, as so large a number of new species are described, it is evident that the volume will be an indispensable necessity to every future student of the Neotropical Adephaga. It contains moreover what is practically a new classification of the family Carabidæ. Its author has long been known and respected as an entomological systematist, for it is now nearly twenty-five years since he inaugurated a rational classification of the Rhopalocera or butterflies. He has been recognised since the death of Baron Chaudoir as the one entomologist possessing an extensive yet intimate knowledge of the Carabidæ of the whole world. But Chaudoir, though he published a crowd of valuable memoirs on the family, died without leaving behind him any general work on its classification. It is therefore a matter for congratulation that the author of this beautiful volume has presented us with a systematic arrangement as complete as the faunistic nature of the work permitted; it is one that requires, indeed, comparatively little supplement from the faunæ of other countries to render it quite complete. Assisted by the labours of Latreille, Dejean, Lacordaire, Schiödte, Leconte, and Chaudoir, and availing himself largely of the valuable work recently published by Horn, he has been able to form of the numerous sub-families, which are the equivalents of Horn's tribes, aggregates of greater importance, which he terms subdivisions. The family Carabidæ is of such enormous extent—12,000 species being known, with a vast number of others to come—that the necessity of some series of intelligible aggregates subordinate to the division, but superior to the tribe or sub-family, is undeniable, and Mr. Bates' attempt to furnish such a series is therefore of great value, even though his subdivisions are at present capable of only loose and partly traditional definition. The division II, of Carabidæ comprises eight of these subdivisions based chiefly on the form and sexual clothing of the male tarsi and on the form of the apices of the elytra. It is evident that the classification of such an enormous complex as the Carabidæ will require for its perfection the combined efforts of many naturalists, and if Mr. Bates's subdivisions are sufficiently natural they will be gradually evoluted and perfected by others, and we may therefore indicate that the first of them, viz. the Diversimani or Pedunculati seems scarcely tenable. The variability of structure of an organ amounts only to a negative, not a positive statement, and is therefore useless for practical purposes; and if we add to this, that other characters now considered in the Carabidæ to be of much importance, such as the number of glabrous joints at the base of the antennæ, are also subject to much variation in the aggregate, it is evident that a change in its composition is inevitable. We would also venture to call in question the propriety of treating the Pseudomorphinæ as merely a sub-family of Truncatipennes. Horn accords them the much higher rank equivalent to the "division" of Bates, and as they are to a considerable extent synthetic between the universally recognised two great divisions of Carabidæ, it is probable that this will, from a systematic point of view, prove nearly correct. Bates, however, only expresses himself with considerable hesitation on this point, and as the group is chiefly Australian, it will devolve on some student of the Australian fauna to work out this question of primary importance to the classification of the Adephaga.

The thirteen plates with which the volume is adorned supply coloured figures of no less than 325 species representing upwards of 100 genera. The figures are lithographs coloured by hand, and though they are, we believe, about the best that can be obtained in this country at present, they are certainly not equal to some of the refined lithographic figures of insects that have in recent years been produced in Austria; they are, however, so good as to enable the species to be recognised from them with certainty, and will therefore be a very welcome boon to entomologists.

Messrs. Godman and Salvin, the editors of the work, are to be congratulated on this satisfactory completion of the first part of the Coleoptera. No faunistic work that has hitherto been published gives anything near to so complete an idea of the vast wealth of tropical nature in insects, it being usual for only a few of the more conspicuous forms of this class to be described or illustrated; and if the Insecta can be completed in a manner at all corresponding to this first instalment, we shall have a work quite without rival in its way, and that will be pointed out as an illustration of what can be accomplished in our country and generation by the liberality and energy of private individuals. The assistance rendered to science by the publication of this volume has been supplemented by the presentation to the nation of the magnificent collection of Geodephaga accumulated by Mr. Godman for the purposes of the work; it consists of 986 species, and nearly 8000 specimens, something like 400 of the species being represented by the typical examples, and is now in the British Museum of Natural History at South Kensington.

D. S.

OUR BOOK SHELF

Outlines of Natural Philosophy. By J. D. Everett. (London: Blackie and Sons, 1885.)

"THIS book is intended to supply the widely-felt want of a work at once easy enough for a class reading-book and precise enough for a text-book." "The woodcuts with which the work is profusely illustrated are not thrown in for mere ornament, but have been carefully *designed* and selected for the elucidation of the text, and are fully explained." Had it not been for the single word which we have put in italics in the second of these extracts from the Preface, we should have at once concluded, from its general tenor, that this work was written to explain a long series of plates (most of them unmistakably French) which have already done duty in various elementary books. We were reminded of Warrington's exhortation, when he brought the proof-plate to Pendennis:—"Now, boy, here's a chance for you. Turn me off a copy of verses to this."

These plates form a wonderful collection. Some are really excellent; not only from the scientific, but even from the artistic, point of view. In others, notably Figs. 88, 93, 94, 101, 102, 130, 160, the artistic predominates over the scientific to such an extent as to render them positively misleading to the beginner. Thus in Fig. 88 the shadow of a sphere, cast by a luminous point on a plane, is drawn in such a manner as to outrage all the Laws of Projective Geometry; and the pleasing sketch Fig. 93 can only be explained (if at all) by a most peculiar state of the air over the still water. Thus, the eaves of a house are depicted as seen by reflection at a portion of the water-surface, from which (as the drawing shows) they are absolutely concealed by a hedge, while the image of the sloping roof above appears exactly as the roof itself does to the distant spectator who is nearly at the same level! Such at least must be the case, unless we make the audacious supposition that the more distant parts of this picture represent a flat surface, the drop-scene of a theatre!! Let the reader try to put his hand and its images in the aspects shown in Fig. 94; or let him try, as in Fig. 101, to see by *all but direct* reflection in a concave mirror an object situated far beyond its rim! On the other hand there are some wierd or Rhadamanthine scenes (as Figs. 134, 135, 138); and a couple at least (Figs. 99, 139) quite Lavaterian in their graphic realisation of human imbecility.

With such a frame-work or skeleton what could be expected of the book? Certainly not much; and it is so far to the credit of Prof. Everett that he has realised a fair amount of that little. But to what class of readers this book can possibly be of use, is one of those unfathomable questions which only a Mental Philosopher dares to attack. There is not, so far as we have seen, any *reasoning* in the book. Statements merely, and illustrated by pictures! To each paragraph, when the imprint of its figure-nucleus or *cliché* has been exhibited, we might append a slight but important variation of the usual mathematical formula:—

QUOD ERAT MONSTRANDUM!

The Moon, Considered as a Planet, a World, and a Satellite. By James Nasmyth, C.E., and James Carpenter, F.R.A.S., late of the Royal Observatory, Greenwich. With 26 Plates and numerous Woodcuts. (London: Murray, 1885.)

THIS is a third edition of a book which we have already reviewed in our columns. The two previous editions were issued in the quarto form, the present one is in the octavo. It is well known that this work contains the most exquisite illustrations of lunar phenomena extant. They chiefly consist of photographs of models which, when placed in the sun-light, faithfully reproduce the lunar effects of light and shadow. Lovers of astronomy are much indebted to Mr. Nasmyth for his brilliant idea, and it is to be hoped that this re-issue in a cheaper form will bring this admirable volume within the reach of many who have previously been debarred from perusing it.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Weather Forecasts

IN your number for November 2, 1882, you were kind enough to insert a letter from me on the subject of "Weather Forecasts." The letter was occasioned by what appeared to me a conspicuous failure in the forecast which was published in the newspapers for October 24. In consequence of communications which followed the publication of my letter and my own consideration of the subject, I was led to move in the House o Lords for a Return of the "Storms which have visited the British Islands between January 1, 1874, and December 31, 1883, and of which no warning has been issued from the Meteorological Office; with a Notice of the Quarter from which each Unwarned Storm has reached the Coast." This Return, which was ordered to be printed August 7, 1884, is in some respects a remarkable document. It contains a record of nearly 120 unwarned storms, or an average of nearly 12 in each year. Large as this number appears to be, I was not encouraged by the correspondence which I had with several experts to hope that much could be done to improve the system of forecasting, and I have taken no further action.

One point, however, connected with the Return appears to me to deserve notice.

On examining it I found to my surprise that the storm of October 24 was omitted altogether. This seemed to me to be strange; but my friend, the Rev. F. Redford, a well-known local meteorologist (since deceased), gave me some technical explanation of the omission with which I was compelled to rest content. In the interesting Blue-Book, however, entitled "Principles of Forecasting by means of Weather Charts, by the Hon. Ralph Abercromby," issued by the authority of the Meteorological Council, I find the failure connected with the great storm of October 24, 1882, duly chronicled and recognised. These are Mr. Abercromby's words (p. 91):—

"Our last illustration will be that of a kind which fortunately rarely occurs, viz. the sudden formation of a cyclone in an unexpected position, which entirely upsets all forecasting. In Fig. 62 [the figure is of course here omitted] we give a chart for 6 p.m., October 23, 1882. In it we see the most familar features of the westerly type of weather, and though the barometer was falling over the Bay of Biscay and rising over Scotland, there was no reason to expect that the ordinary sequence of that kind of weather would be disturbed, that is to say, that west and south-west winds, with rather showery weather, would prevail. Accordingly the following forecasts were issued."

Then follows the table of forecasts as given in my letter before referred to, and ending with "Warnings, none issued."

"When we come to look, however, at Fig. 63 [this figure here omitted], the chart for 8 a.m. the following morning, we find that a small well-defined cyclone had formed during the night over the English Channel, which moved during the day towards north-north-east, and thereby produced continuous rain with complete shifts of the wind through 180° in many parts of the country, *so that the forecasts issued were a complete failure.*"

Now, observe Mr. Abercromby's practical conclusion:—

"It may be well to consider how failures of this sort may be guarded against. The answer undoubtedly is, by taking observations at shorter intervals than fourteen hours, as on this occasion. On this particular night a halo—a sure sign that the cyclone had begun to form—was seen near London at 10 p.m., and it is therefore certain that if the observations could have been taken at 11 p m., or midnight, *such a complete failure might have been avoided.*"

These words seem to imply that something more might be done to give warning of storms. If we undertake to give these warnings, we ought not to let any question of expense stand in the way of making the warnings as complete and as correct as possible. An unwarned storm occurring on an average once a month is a serious consideration. It is not worthy of the greatest maritime nation in the world to be neglectful or niggardly in this matter.

H. CARLISLE

Rose Castle, Carlisle, November 20

P.S.—I forward herewith a copy of the Return of "Unwarned Storms."

Scandinavian Ice-Flows

REFERRING to the map in Croll's "Climate and Time," which is reproduced in his "Climate and Cosmology" (p. 133), and which traces the ice-flows of the Glacial period from the two sides of the Scandinavian peninsula, it will be seen that the said flow bifurcates in the North Sea, and that the bifurcation is at the position of the Dogger bank. I should be glad to be informed whether this fact has been observed or commented upon in any geological work.

J. D. HOOKER

Kew, November 23

Can an Animal Count?

SIR JOHN LUBBOCK, in his interesting paper on animal intelligence (NATURE, vol. xxxiii. pp. 46-7), virtually puts this question with reference to the dog. But the question whether a dog, or any other animal, can count will depend upon what we mean by counting. In the ordinary and correct signification of the term, counting consists in applying conventional signs to objects, events, &c., as when we say "one," "two," "three," to the striking of a clock. Clearly in this sense there is no reason to suppose that any animal can count. But there is another sense in which the term "counting" may be used—*i.e.* as designating the process of distinguishing, with respect to number, between the relative contents of two or more perceptions. While addressing an audience of 100 individuals a lecturer can immediately perceive that it does not contain 1000; and even without, in the true sense, counting them may make a tolerably close guess at their number. The accuracy of such a guess will depend upon two conditions. The first of these is the number of units to be computed, and the second is the previous practice he may have had in that kind of computation. Thus, every man is able to tell the difference between one and two, two and three, &c., up to perhaps seven and eight objects or events, without resorting to the expedient of marking off each with a separate sign. But somewhere about this point most persons require to adopt a system of numerical notation, if they desire to be accurate; and probably no one, without either special practice or some such system, could be perfectly sure whether he held eleven or twelve shillings in his hand, or whether a clock had just struck eleven or twelve. Indeed, it is just because of the rapidly-increasing difficulty of thus computing diminishing differences of ratio by immediate perception, that primitive man first lays the foundations of arithmetic by marking off the objects or events upon his fingers and toes. As already indicated, however, special practice makes a great difference in the accuracy with which such instantaneous computation can be made. Several years ago Prof. Preyer, of Jena, tried some experiments upon this subject, and found, if I remember correctly, that after a course of special training one might acquire the power of instantaneously distinguishing between twenty and twenty-one dots promiscuously scattered over a piece of paper.

Now, it is clearly only in this way that animals can be supposed to count at all; and, therefore, the only question is as to how far they are able to take immediate cognisance of the precise numerical content of a perception—or, in the case of a series of events, how far they are able to take similar cognisance of their past perceptions. But, as Sir John Lubbock observes, there is no record of any experiments having been made in this direction. Houzeau (tom. ii. p. 207) says that the mules used in the tramways at New Orleans are able to count five; for they have to make five journeys from one end of the tramway to the other before they are released, and they make four of these journeys without showing that they expect to be released, but bray at the end of the fifth. If this is really a case of "counting," in the incorrect sense of the term (and not due to observing some signs of their approaching release), it is probably due to their perception of a known amount of fatigue, a known duration of time, or some other such measure.

Several years ago my sister tried to teach an intelligent terrier to fetch a stated number of similar little woollen balls placed in a box at a distance from herself—the number stated, or ordered, being purposely varied from one to six. But although she is good at teaching animals, and here went to work judiciously in ways which I need not wait to describe, the result, as in the case given by Sir John Lubbock, was a total failure.

My object in making these remarks is to point out that in experiments of this kind the game seems scarcely worth the candle. Even if it were proved that a dog could "count" up to any particular number, all that we should have proved would be that the dog is able to distinguish between the degrees of two or more perceptions of a given kind; we could not thus prove any abstract conception of number on the part of the animal, such as is implied on the part of the "Damara floundering hopelessly in a calculation." Howsoever hopeless such floundering may be if the man is really *calculating—i.e.* employing some system of numerical signs—his operations are being conducted on a totally different psychological level from those of the bitch who, in surveying her litter of puppies, perceives that there is not so great a mass of them as she remembers to have perceived before. Psychologically considered, the artifice of numerical notation is as far above any such faculty of simple perception, as the artifice of alphabetical writing is above that of simple association. I cannot doubt that a moment's thought would have shown Sir John Lubbock how needless was his precaution—while establishing certain associations of ideas in a dog's mind between written words on a card and the things signified—of spelling the words phonetically, "so as not to trouble him by our intricate spelling."

It is a most interesting fact that a dog's attention can be so far fixed upon written signs that a special association of ideas admits of being established between them and the things signified; but the psychological distance between establishing such a special association and spelling a word is so enormous as not to admit of computation. And similarly, even if my sister had succeeded in teaching her terrier to fetch a stated number of balls at word of command, no one could have supposed that she had thus taught the animal to count, in the sense of employing any system of numerical notation: she would only have proved the degree in which this animal was able to perceive, *without counting*, the different appearances presented by this, that, or the other volume of balls in a box.

GEORGE J. ROMANES

Lodge's "Mechanics"

PERMIT me to thank Prof. Tait for his kind and amusing criticism of my little book. I am struck with comic horror at the thought that anything in the preface can be construed into a comparison between works like Thomson and Tait, Clerk-Maxwell and W. K. Clifford, with such elementary picture-books as Deschanel and Ganot. I do not indeed share Prof. Tait's contempt for these "foreign" books; a student will find in them details, about (say) barometers or air-pumps, for which he may search the other works mentioned in vain. I did not urge students to read Thomson and Tait, because to those who can the advice is superfluous; to those who cannot it is disheartening. I did, and do, recommend such junior students as we get at provincial colleges to read easy works on Physics—not always because they contain a profound and satisfactory statement of principles, for how few of them do, but because they explain a multitude of details and experimental developments with which it was unwise to encumber a little book dealing mainly with vital principles, and aiming at being, in its humble way, an introduction to the classics of the science.

My book is primarily intended as milk for babes; and while it would be cruel to tell a baby to look at the sun, it is possible to direct his attention to a gas-light with some pleasure and satisfaction. OLIVER LODGE

University College, Liverpool, November 13

The Resting Position of the Oyster—A Correction

IN a late number of NATURE (vol. xxxii. p. 597) Mr. J. T. Cunningham makes the extraordinary announcement that Woodward, Jeffrey, and Huxley were wrong in asserting that the oyster rests on the left side. I am in a position to state with positive certainty that it is invariably the left valve of the fry of the oyster which becomes affixed to a foreign object. I have examined thousands of very young adherent spat ranging in size from 1-90th of an inch to 2 inches in diameter, and have never found an exception to this rule. Besides the positive statements to the same effect made by Huxley and others, I would refer the reader to a brief paper by myself entitled "On the Mode of Fixation of the Fry of the Oyster" (*Bull.* U.S. Fish Commission, vol. ii., 1882, pp. 383-387); but I would caution the reader that Figs. 3 to 8 were reversed through an unfortunate oversight, as the apices of the umbos of all the larval shells figured on p. 387 should be directed to the left instead of to the right side. This blunder of the artist is pointed out in the explanation to plate 75, where the figures from the above-cited notice are reproduced in my paper entitled "A Sketch of the Life-History of the Oyster," forming Appendix II. to "A Review of the Fossil Ostreidæ of North America," by Charles A. White, M.D., and Prof. Angelo Heilprin. In another paper of mine, "The Metamorphosis and Post-Larval Development of the Oyster," Rep. U.S. Fish Commissioner, Part 10, for 1882, p. 784, Fig. 2 shows the larval shell, L, of the young spat in normal position, with the umbo directed to the left. This figure may be compared with advantage in respect to the points raised here with the figure of the external anatomy of the adult on plate 73 in my "Sketch of the Life-History of the Oyster," already cited.

Mr. Cunningham's inference that the left valve, usually regarded as the lower one, is really the upper, because he finds worm-tubes and hydroids most abundant on the convex or left valve, is founded upon an imperfect acquaintance with the habits of the oyster. For, if living oysters are thrown into the water they will invariably fall upon the bottom with the left valve downward. If dead oyster-shells—free valves—be similarly thrown into the water, they will invariably fall with the hollow side up, and the convex one down. And furthermore, both living and dead shells remain in just the position in which they fall. Dead shells sown as cultch, or collectors, fall in such a position, and most of the spat is "caught" on the exposed parts of the under surface of such shells, whereas little is found on the upper surface. The reason for this is that the sediment which is deposited on the upper surfaces, asphyxiates the young oyster-fry and the other larvæ which affix themselves before they can become established and strong enough to resist its effects. The affixed organisms on the exposed inclined under surfaces of the shells, are, on the other hand, protected from the accumulation of sediment.

It is also well known that the right valve of the oyster is always the most deeply pigmented, while the lower or left one is paler. This is always the case when oysters lie almost flat on the bottom. When crowded together on the natural banks in a vertical position, there is less difference between the colours of the valves. This difference is obviously due to some influence exerted by the position of the aspects of the body of the animal in respect to light, the same as in land and aquatic animals generally. I would conclude, for this last reason alone, that the right valve of the oyster is normally always uppermost, were it not for the fact that I have observed all the stages of transition from the spat to the adult condition in confirmation of such a conclusion. It is true that many young oysters have the right valve looking down when allowed to grow upon cultch or shells which have been sown upon the bottom to favour the collection of the spat, but that circumstance by no means subverts the conclusions of such cautious and careful observers as Brooks, Woodward, Jeffrey, Huxley, Horst, and others.

JOHN A. RYDER

Smithsonian Institution, Washington, U.S.A., November 11

The Rotation Period of Mars

ONE or two points in Prof. Bakhuysen's investigation of the rotation period of Mars require correction:—

First, my determination of the period, as finally corrected, was 24h. 37m. 22·72s., correct within 0·02s. The correction arose from the detection of a small clerical error. My final result was deduced from a comparison of observations by myself in 1873, with observations by Kaiser in 1864, Madler in 1830–1837, Sir W. Herschel in the last quarter of the eighteenth century, Huyghens and Hooke in 1666. I have since used the best observations during the oppositions of 1881 and 1883, without finding any occasion for changing my result even by one-hundredth part of a second, though I place no reliance on the second decimal figure.

But, secondly, Prof. Bakhuysen, like Mr. Denning some time since, has taken Kaiser's result uncorrected for the clerical errors—very seriously affecting it—which I detected in 1873. Kaiser counted three days too many in comparing Hooke's observation with his own: one day through a mistake in correcting for change of style, and two days (apparently) from counting the years 1700 and 1800 as leap-years. His thus taking three days too many of terrestrial time had the effect—since three corresponding Martian rotations were taken in—of introducing a deficiency amounting to three times the excess of a Martian over a terrestrial day, that is, 3×37m. 22·7s., or 67,281 tenths of a second. This, divided by the total number of Martian rotations, about 88,900, gives as a correction about 0·077s. to be added to both Kaiser's estimates, making them respectively 24h. 37m. 22·697s. and 24h. 37m. 22·668s., the mean of which, 24h. 37m. 22·6825s., is practically the same as the value I assigned, viz. 24h. 37m. 22·7s.

I think it probable that Schmidt (and perhaps Prof. Bakhuysen, too) followed Kaiser so far as the error of three days was concerned. It would naturally be taken for granted that this part of Kaiser's work was free from error. If I had not been determined to find out where and how Kaiser's calculations differed from my own, I should not have found out his mistake, for certainly one would not expect to find two large errors in a work perfectly free from small ones. But so it was. I may remark that Prof. Newcomb, of Washington, went through my calculation, finding it correct, and that Kaiser really had made the mistake I indicated.

As this correction re-established what Kaiser had doubted, the accuracy of Hooke's observations, and of my own interpretation of them, Prof. Bakhuysen's correction is scarcely admissible. For a difference of 0·06s., multiplied by 88,900 for the Martian rotations between Hooke and Kaiser in 1873, gives a total discrepancy of an hour and a half, nearly all of which must be assigned to Hooke's observations and Huyghens' (which I brought into agreement with Hooke's by correcting Kaiser's one-day error for change of style).

RICHD. A. PROCTOR

5, Montague Street, Russell Square, W.C., November 23

Beloit College Observatory

MY attention has been called to a paragraph in NATURE (vol. xxxii. p. 514), which, quoting from *Science*, speaks of "the Astronomical Observatory of Beloit College as closed for lack of funds." It is not strange that you express surprise at this announcement. Permit me to say that it is positively untrue. So far as I can learn, the only authority for it is a strange and entirely unwarranted statement from our late Director. Mr. Tatlock's connection with our Observatory closed on July 1 last. Within one week of that date Mr. Charles A. Bacon was appointed his successor, and a few weeks later he appeared and took charge. He has already proved himself competent, both as an observer and as an instructor. New arrangements are made for both meteorological and astronomical observations, and special attention will be given to solar and spectroscopic work. Though not richly endowed, our "Smith Observatory" is well equipped, and under its present direction its facilities will be made helpful to both the advancement and the diffusion of science. A. L. CHAPIN

Beloit College, Wisconsin, October 31

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES OF THE BRITISH ASSOCIATION, HELD AT ABERDEEN

A NEW branch of the British Association glided unobtrusively into existence at Aberdeen, under the new rules passed in the previous year: I mean the Conference of Delegates of Corresponding Societies. The Committee to whom the general arrangements connected with this new branch is intrusted are now issuing a circular to the Corresponding Societies, signed by myself as its Chairman, and by Prof. Meldola as its Secretary, in which they give an account of the proceedings at Aberdeen, with comments thereon. Much of this will be of general interest, as it helps to explain the functions of the Conference, which, as the proceedings showed, were imperfectly understood by many of the delegates themselves. The report is too long to ask you to print it in full, and on the other hand its general purport is more easily seized by leaving out details. I therefore limit myself to sending you extracts from it, with connecting-links of explanation to make them read continuously.

The Corresponding Societies Committee of the British Association beg to lay the following statement of work done at Aberdeen, with comments thereon, before the Presidents and Councils of the various Societies whose applications for enrolment as Corresponding Societies of the British Association had been granted.

The Conference of Delegates was held on Thursday, September 10, and on Tuesday, September 15, both meetings having been called at 3.15 p.m., and lasting in each case about one hour.

(Here follows a list of the various Corresponding Societies and of the attendance of their respective representatives.)

At the first meeting

The Secretary read the first report of the Corresponding Societies Committee, which had been presented to the Council and accepted by the General Committee of the British Association. Methods of procedure were then discussed, and explanations as to the functions of the Conference were given by the Chairman and Secretary in reply to questions or otherwise.

After some informal conversation, invited by the Chairman for an interchange of views, in which suggestions were made as to the nature of the work which might be taken up by Local Societies,

The Chairman explained that although individual delegates might perhaps like to take advantage of the Conference to mention informally and when time permitted, any work in which their Society was engaged, with the object of comparing views with, or obtaining assistance from, their brother delegates, it did not fall within the functions of the Conference to suggest or to initiate any scheme of local investigation. It was their function simply to consider how such schemes of the kind, as had been previously considered and adopted by the British Association, through its General Committee, could be best carried out. If any delegate desired to formally propose to the Conference any subject for local investigation, he must do so through the regular channels along which all proposals that receive the sanction of the British Association have to pass. In such cases the subject must first be brought before the Committee of the Section within whose province it lies. It is for that Sectional Committee in the first instance to discuss its merits, and if they approve of the idea they will forward it, backed with their approval, to the Committee of Recommendations, whose duty tt is to revise all such proposals, especially when they involve grants of money, and to submit them in their revised form to the General Committee, under whose sanction they become invested with the full authority of the British Association. Every proposal that has been approved by a Sectional Committee, and is concerned with local investigation, will be forwarded under the new rules by the Secretary of the Section to the Secretary of the Conference, at the same time that he forwards it to the Committee of Recommendations. The hour and day of the meetings would not admit of delaying the consideration of the proposals by the Conference until they had passed through their final stages and had received the formal sanction of the Association, but practically little or no difficulty will arise from this forestallment of their final approval, because it is a matter of experience that the deliberate approval of a Sectional Committee is rarely over-ruled on after-consideration, except it be on the grounds of finance, in which case the investigation would simply be abandoned. The real point of importance is that every proposal should pass its first and principal ordeal before a Sectional Committee before it becomes admissible as a subject of formal consideration by the Conference of Delegates. He also reminded the Conference that, in accordance with Rule 7 of the rules relating to Corresponding Societies, "The Conference may also discuss propositions bearing on the promotion of more systematic observation and plans of operation, and of greater uniformity in the mode of publishing results."

At the second meeting of the Conference the following recommendations for the appointment of Committees intrusted with local inquiries were read to the Conference:—

(1) For the purpose of defining the racial characters of the inhabitants of the British Isles. Dr. Garson explained the objects of this Committee, and invited the co-operation of the Local Societies.

(2) For the purpose of recording the position, height above the sea, lithological characters, size, and origin of the erratic blocks of England, Wales, and Ireland, reporting other matters of interest connected with the same, and taking measures for their preservation.

(3) For the purpose of investigating the circulation of the underground waters in the permeable formations of England, and the quality and quantity of the water supplied to various towns and districts from these formations.

(4) For the purpose of inquiring into the rate of erosion of the sea-coasts of England and Wales, and the influence of the artificial abstraction of shingle or other material in that action.

Mr. C. E. De Rance made brief statements explanatory of the work of each of the three foregoing Committees, and pointed out the manner in which assistance could be rendered by the Local Societies.

A letter was read from the Secretary of Section D, transmitting a recommendation that the subject of the preservation of the native plants of this country should be brought under the notice of the Local Societies, and deputing Prof. W. Hillhouse to bring this subject before the delegates present at the Conference.

In accordance with the foregoing recommendation, Prof. Hillhouse gave numerous instances of the extermination of rare plants from certain localities by dealers, to whom their habitat had become known. He stated that, having been empowered by the Sectional Committee to represent their views on this subject, he had thought it desirable to draw up the following protest:—

"We view with regret and indignation the more or less complete extirpation of many of our rarest or most interesting native plants. Recognising that this is a subject in which Local Societies of naturalists will take great interest, and can exercise especial influence, we urge upon the delegates of Corresponding Societies the importance of extending to plants a little of that protection which is already accorded by legislature to animals and prehistoric monuments, and of steadily discouraging and, where possible, of preventing any undue removal of such plants from their natural habitats; and we trust that they will bring these views under the notice of their respective Societies."

It was then arranged: (1) That the above gentlemen (or, if more convenient, the Chairman or the Secretary of the Committees they severally represent) should communicate with each of the delegates as soon as the details of their proposed investigations had been matured. (2) That each delegate should thereupon do his best to interest the members of his Society, and, if thought desirable, the Society itself, in the subject of investigation, and should send to his correspondent the names and addresses of such persons in his neighbourhood as might be likely to render willing and effectual help, so as to put him at once in direct communication with them.

It was further agreed that, with the view of making the delegates personally acquainted with one another, it was advisable to give them an opportunity of dining together at an early day during the meeting, and Prof. Meldola was authorised to make the necessary arrangements for the following year at Birmingham. Thursday was suggested as a convenient day for the dinner, but it seems better on reconsideration to adopt Wednesday, at 6. After the dinner the delegates would proceed to the places reserved for them at the opening evening meeting to hear the President's address. Particulars of the place and cost of the dinner, &c., will be posted on the notice board in the reception room.

The Corresponding Societies Committee have now to point out that, although thirty-nine Societies were admitted as Corresponding Societies, only twenty-three of them nominated delegates. Of the twenty-three delegates only eleven were present at the final meeting to hear the explanations of the gentlemen who attended for the purpose of making them, and of placing themselves in personal communication with the several delegates. The Committee feel sure that the delegates who failed to attend the Conference had not realised the character of the engagement into which they had entered, and that they must have erroneously regarded their title and privileges as purely honorary, and their duties as sinecures. The Corresponding Societies Committee desire it to be clearly understood that such is not the case, as the work intrusted to the delegates is real and important. Conspicuous notices of the times and place of meeting of the Conference had been posted in prominent positions in the reception room and in the sectional rooms, so that ignorance of the meetings could hardly be pleaded in excuse. The position of each delegate is that of a person of scientific influence in his own neighbourhood, who, by the acceptance of his title and its privileges, pledges himself to act as a friendly intermediary between those Committees of the British Association who are occupied with local investigations and the local scientific men who are known to him. It is his duty to make himself well informed of the nature of the proposed inquiries sanctioned by the British Association as personally explained by the representatives of the respective Committees, and to qualify himself as far as possible for the honourable post of local correspondent. It is in return for the prospect of this very valuable assistance that the position of a member of the General Committee is granted to each delegate, and the privilege is accorded of having published in the *Reports* of the British Association a catalogue of the local investigations of the Society which he represents. Hereafter the Corresponding Societies Committee will take into consideration the advisability of not recommending for re-election those Societies whose delegates fail to attend the meetings of the Conference without adequate explanation.

These views were expressed by the Chairman at the second meeting of the Conference, and they appeared to be fully in harmony with the feelings of the delegates who were present.

The above extracts contain all that is of general importance in the circular letter. Whether or no the Conference of Delegates will grow into an important branch of the British Association remains to be seen. The rules under which it is established ought to secure it from the danger of provoking the jealousy of Local Societies by the assumption of a dictatorial attitude towards them and by interfering in their concerns; on the other hand they as surely prevent it from growing into the anomalous office of an *imperium in imperio* as regards the British Association. Consequently the success of the Conference appears wholly to depend on an abundant and continuous supply of good work being found for it to do, and on a sufficiency of zeal among the delegates to perform their duties efficiently.

FRANCIS GALTON

DR. CARPENTER, C.B., F.R.S.

A SHORT sketch of the life and work of the eminent naturalist who has recently passed from among us will be welcome to the readers of NATURE.

William Benjamin Carpenter was born at Exeter in 1813, and was the fourth child and eldest son of Dr. Lant Carpenter, a Unitarian minister. His sister, Mary Carpenter, who died a few years since, achieved the most important work as a philanthropist, in relation to the treatment of prisoners and to questions affecting our Indian fellow-subjects, and will be remembered by future generations with no less gratitude than her brother.

In his childhood Dr. Carpenter received an excellent education, comprising both classics and the principles of physical science, at the school established by his father at Bristol, and it was his intention to adopt the profession of a civil engineer. He was, however, persuaded to accept the opportunity offered by a medical practitioner, Mr. Estlin, of Bristol, and to enter on the study of medicine as apprentice to that gentleman. Shortly after this he was sent, as companion to one of Mr. Estlin's patients, to the West Indies, and on his return from this visit he entered, at the age of twenty, the medical classes of University College, London. After passing the examinations of the College of Surgeons and the Apothecaries' Society he proceeded to Edinburgh, where he graduated as M.D. in 1839.

His graduation thesis on "The Physiological Inferences to be deduced from the Structure of the Nervous System of Invertebrated Animals" excited considerable attention, especially on account of the views which he advanced as to the reflex function of the ganglia of the ventral cord of Arthropoda.

From the first Dr. Carpenter's work showed the tendency of his mind to seek for large generalisations and the development of philosophical principles. He was a natural philosopher in the widest sense of the term—one who was equally familiar with the fundamental doctrines of physics and with the phenomena of the concrete sciences of astronomy, geology, and biology. It was his aim, by the use of the widest range of knowledge of the facts of Nature, to arrive at a general conception of these phenomena as the outcome of uniform and all-pervading laws. His interest in the study of living things was not therefore primarily that of the artist and poet so much as that of the philosopher, and it is remarkable that this interest should have carried him, as it did, into minute and elaborate investigations of form and structure. Although some of his scientific memoirs are among the most beautifully illustrated works which have been published by any naturalist, yet it is noteworthy that he himself was not a draughtsman, but invariably employed highly skilled artists to prepare his illustrations for him. Yet we cannot doubt that the man who, with his dominant mental tendency to far-reaching speculations, yet gave to the world the minute and ingenious analysis of the beautiful structure of the shells of Foraminifera, had an artist's love of form, and that the part of his life's work (for it was only a part among the abundant results of his extraordinary energy) which was devoted to the sea and the investigation of some of its fascinating living contents, was thus directed by a true love of Nature in which ulterior philosophy had no share.

Two books, Dr. Carpenter has told us, exerted great influence over his mind in his student days: they were Sir John Herschel's "Discourse on the Study of Natural Philosophy" and Lyell's "Principles of Geology"—that great book to which we owe the even greater books of Charles Darwin. Taking the "Principles" in some way as his model, Dr. Carpenter produced in 1839 his first systematic work, under the title "Principles of General and Comparative Physiology, intended as an Introduction to the Study of Human Physiology and as a Guide to the Philosophical Pursuit of Natural History." Admirable as was the execution of this work in many ways, its great merit lay in the conception of its scope. It was in fact the first attempt to recognise and lay down the lines of a science of "Biology" in an educational form. Carpenter's "Comparative Physiology" is the general or elementary "Biology" of the present day—traced necessarily upon the less secure foundations which the era of its production permitted, viz. one year only subsequent to the date of Schwann's immortal "Microscopical Researches."

For five years Dr. Carpenter remained in Bristol, commencing medical practice and marrying in 1840; but in 1844, feeling a distaste for the profession of medicine, he removed to London in order to devote himself entirely to a literary and scientific career. He was encouraged to take this step by the success which his "Comparative Physiology" obtained, a second edition having been called for within two years of the publication of the first. He was appointed Fullerian Professor of Physiology in the Royal Institution during his first year in London, and Professor and Lecturer at University College and at the London Hospital, whilst he was also elected a Fellow of the Royal Society.

In 1851 Dr. Carpenter became Principal of University Hall, the residential institution attached to University College, where he remained until 1859. During this period he remodelled his treatise on Physiology, issuing the more general biological portion as "Comparative Physiology," whilst that portion dealing with the special physiology of man and the higher animals appeared as his well-known "Human Physiology," which subsequently ran through many editions. The "Human Physiology" is remarkable in the first place for the chapters on the physiology of the nervous system, and especially for the theories enunciated with regard to the relations of mind and brain, and the attempt to assign particular activities to particular portions of the cerebral structure. In arriving at his conclusions Dr. Carpenter had to depend on arguments drawn from the facts of comparative anatomy and of diseased or abnormal conditions in man. There is no doubt at the present day of the acuteness which he displayed in his treatment of the subject, and of the truth in a general way of the results which he formulated. Experiment and a wider range of observation have to some extent corrected—but on the whole rather extended and confirmed—the doctrines of the early editions of the "Human Physiology" in regard to this subject, so that he was able only a few years since to separate this portion of the work and issue it as a separate book, the "Mental Physiology," in which is contained by far the most complete, consistent, and readable account of the phenomena of mind, and their relation to the actual structure of the brain, which exists. Such topics as Instinct, Mesmerism, Somnambulism, Unconscious Cerebration (his own phrase), &c., are discussed in a masterly way, and with an abundance of illustration and knowledge which renders the work one of the greatest value even to those who may differ there and there from its theoretical conclusions.

About the period of his removal to London Dr. Carpenter began to occupy himself with the minute study of the structure of the calcareous shells of the Mollusca—being led thereto by a desire to compare the results of the operation of living matter upon distinctly mineral compounds (such as carbonate of lime), by way of comparison and in illustration of the rapidly accumulating knowledge of cell-structure in the softer parts of living things. This study, which resulted directly in some valuable contributions to our knowledge of the structure of shells, shown by these researches to be far more complex than had hitherto been supposed, led on the one hand to Dr. Carpenter's permanent identification with the pursuit of research with the microscope, and on the other hand to those admirable investigations of the structure and law of growth of the shells of the minute Protozoic Foraminifera which constitute his most weighty contribution to the special literature of science. His microscopic studies bore fruit in the publication of "The Microscope and its Revelations," the sixth edition of which was issued in 1881. The studies on the shells of Foraminifera were continued throughout his life, being published in four memoirs in the *Philosophical Transactions*, and in a richly illustrated monograph produced by the Ray Society in 1862, whilst the last of his memoirs in the *Philosophical Transactions* was that on Orbitolites bearing date so late as 1882. It was on this subject that Dr. Carpenter was busy at the time of his death, having during the past few years accumulated a wealth of material and drawings in support of his contention that the *Eozoon canadense* discovered by Logan in the Laurentian rocks of Canada exhibits the distinctive structure of the shell-substance of the higher Foraminifera. There is reason to hope that the memoir which he had nearly completed on this subject may yet be brought by his son, Dr. Herbert Carpenter, into a finished form and published.

At the age of forty (1853), what with his larger and smaller books, his original researches, his lectures on medical jurisprudence at University College, and numerous popular lectures on scientific topics, Dr. Carpenter's life was unusually laborious and productive.

In 1856 he was appointed Registrar of the University of London, and for twenty-three years administered the onerous duties of that office in such a way as to contribute in no small degree to the success of the University, and above all to the maintenance of the high character of its degrees and the ample recognition of the study of natural science for which the University is now distinguished.

He was able now to give a larger amount of time than formerly to his original investigations, and, in his summer holidays at Arran and elsewhere, commenced, amongst other studies, those researches on the structure and development of the beautiful little feather-star, which were from time to time published in the *Philosophical Transactions*, and led to his association with Wyville Thomson, and thus to the deep-sea explorations of the *Lightning*, and subsequently of the *Challenger*.

Carpenter's memoirs on Comatula give a very full and beautifully illustrated account of the structure of the skeleton of the feather-star, but for many years the view which he entertained with regard to the nature of the axial cord which runs through the segments of the arm-skeleton of that animal was regarded by all other observers (with scarcely an exception) as erroneous. Dr. Carpenter considered these cords as nerve-cords, and after his retirement from official life he made a special visit (only five years or so ago) to the marine laboratory erected by Dr. Dohrn at Naples, in order to test his views by the repetition, on an extensive scale, of experiments which had already appeared convincing to his mind. These experiments, and others since carried out by younger naturalists, have at length fairly established the view for the truth of which the veteran observer had long contended.

The deep-sea explorations which Dr. Carpenter, assisted by Prof. Wyville Thomson, arranged, and for which he succeeded in obtaining the aid of ships of the Royal Navy, were designed not merely to search for organisms in the great depths of the ocean, but especially to study the ocean currents both deep and superficial, Dr. Carpenter having a strong desire to enter upon the explanation of the great physical phenomena presented by the ocean. He himself took part in the earlier expeditions in 1868 and subsequent years, and though unable to leave the ties which bound him to home, so as to join the long *Challenger* Expedition, yet he closely watched the results then obtained, and embodied the whole of his observations, and those reported from the *Challenger*, in some extremely suggestive and important memoirs and lectures on ocean circulation.

In 1879 he retired from the Registrarship of the University of London with a well-earned pension, and was at once chosen as a member of the Senate of that body. He now devoted himself with unabated vigour to the prosecution of his studies on Foraminifera and on Comatula, and to more theoretical matters, such as ocean-currents, and the explanation of the frauds of spirit-mediums. Though released from the duties of office, he was still a constant attendant at the Senate of the University, he rarely missed a meeting of the Royal Society or one of the annual gatherings of the British Association, and, besides undertaking the administration of the Gilchrist trust, delivered many lectures in all parts of the country himself—both independently and as an emissary of the trustees. The scheme of lectures and scholarships instituted by the Gilchrist trustees, which is effecting an important educational work in natural science among classes of society excluded from regular University teaching, is Dr. Carpenter's work. He wrote at this time in the interest of the public health some admirable articles on vaccination, as in earlier life (1849) he had from a similar point of view treated the subject of alcoholic liquors, and had urged the arguments for total abstinence. When past seventy years of age he did not shrink from a journey to the United States, where he spoke and lectured with unflagging vigour. The last public movement in which he took an active part was the foundation of the Marine Biological Association, of which he was a Vice-President, and which is about to carry out, by means of its laboratory on Plymouth Sound, a suggestion which is traceable to his own proposition for the thorough exploration and study of Milford Haven.

The abundant and noble achievements of Dr. Carpenter's public and scientific career did not pass without recognition in the form of awards and titles. He received in 1861 one of the Royal medals awarded by the Council of the Royal Society, and in 1883 the Lyell medal of the Geological Society. In 1871 he was made an honorary LL.D. of the University of Edinburgh, and in 1872 he was President of the British Association for the Advancement of Science, when it met at Brighton. In 1873 he was elected Corresponding Member of the Institute of France, and on his retirement from his official position at the University of London in 1879 he was nominated C.B.

It is impossible to do justice to Dr. Carpenter's character as a scientific man in a few lines: here no attempt has been made to do more than indicate in something like chronological order and connection of subjects the vast amount of work which he accomplished.

Upon the present writer, whose father was his fellow-student at University College, and who has enjoyed since boyhood the privilege of his friendship, Dr. Carpenter always produced the most vivid impression of a man of indomitable energy, who had accepted as the highest duty and keenest delight of his life, the promotion, whether by advocacy or by research, of true knowledge. The tenacity and vigour with which he was wont to expound his views on such matters of research as at the time occupied his thoughts, and the importance and respect which he assigned to all genuine research, were evidences of an earnest and just nature which evoked sympathy and esteem in all men of kindred pursuits.

In reference to Dr. Carpenter's private life and tastes, the following extract from a weekly contemporary states, with the authority of a member of his own family, what might, in its absence, have been here less completely indicated. The journal to which we are thus indebted is an organ of the Unitarian Church, of which body Dr. Carpenter was, throughout life, an active and orthodox member, a fact which may or may not be brought into connection with the fact of his incomplete acceptance of the leading doctrines of Darwinism, though the latter would by no means necessarily follow from the former.

"He was well versed in literature, and turned for refreshment in hours of weariness to his favourite Scott. Political memoirs of his own time were read with the keenest relish, for he had early learned from his father, Dr. Lant Carpenter, to take a high view of a citizen's obligations, and the Bristol riots, which he had witnessed, made a life-long impression upon him. A brief sojourn in Italy called forth a susceptibility to the enjoyment of art, which was a surprise even to himself; and in music, from the time that he had taught himself as a young man to play on the organ, he found unfailing recreation. Nature, likewise, in her vaster as well as her microscopic forms, was for him full of charm and delight, and from every excursion he carried back memories which remained singularly vivid and distinct. In society his immense stores of information, his sympathetic interest in others, his thorough enjoyment of humour though he felt unable to originate it, made him a genial and ever-welcome companion, while his friends learned how strong a confidence might be placed in his faithfulness. Many young men found unexpected help and encouragement in him, and he rejoiced when he could open a way to those who were involved in the struggles through which he had himself once passed. The dominant conception of his life—as was fitting in one of Puritan descent—was that of duty. And if this sometimes took austere forms, and led him to frame expectations which others could not always satisfy, an enlarging experience mellowed his judgment and enabled him to apprehend their position from their point as well as his own. Released from the pressure and strain of earlier life, he was able to give freer play to his rich affections; and in his own family they only know what they have lost who will never again on earth feel his support as husband and father, brother, and friend."

E. RAY LANKESTER

WALTER FLIGHT, D.Sc., F.R.S.

THE close of this year has witnessed the termination of another bright and promising life, ended all too soon for the hopes and expectations of his many friends.

Walter Flight was the son of William P. Flight, of Winchester, in which city he was born on January 21, 1841. He was sent, after a period of pupilage at home, to Queenwood College, Hampshire, in the days when George Edmondson was head master, and Tyndall and Debus were the teachers of science. From Queenwood he went to the University of Halle, where, in the laboratory of Prof. Heintz, he pursued his chemical studies during the winter session of 1863-64. During 1864 and 1865 he entered the University of Heidelberg, where, in the laboratories of the celebrated Profs. Bunsen, Kopp, and Kirchhoff, he applied himself early to acquire that thorough knowledge of the various branches of theoretical and practical chemistry, and that marked facility for overcoming experimental difficulties which characterise the practised and careful worker. From Heidelberg Flight passed to the University of Berlin, where he remained until 1867, studying and working in Prof. Hofmann's laboratory, and for a time filling the office of his Secretary and Chemical Assistant.

Returning to England in 1867, he graduated D.Sc. in the University of London, and in the following year was appointed by the Senate to the office of Assistant Examiner under Prof. Debus (his former teacher at Queenwood). On September 5, 1867, Dr. Flight was appointed an Assistant in the Mineralogical Department of the British Museum. Here, under the direction of Prof. Maskelyne, the Keeper of Mineralogy, he commenced a series of researches into the chemical composition of the mineral constituents of meteorites and the occluded gases they contain. Many of the methods by which he carried out these investigations were originated by him in the course of the research, and displayed in a remarkable degree his skill and ingenuity in chemical manipulation.

He was shortly after this date appointed Examiner in Chemistry and Physics at the Royal Military Academy, Woolwich, and in 1876 Examiner to the Royal Military Academy, Cheltenham.

For several years Dr. Flight served on the Luminous Meteors Committee of the British Association, to which he lent much valuable assistance.

Between the years 1864 and 1883 he was author of twenty-one original papers, including "A Chapter in the History of Meteorites," which appeared in a succession of twenty-three articles in the *Geological Magazine* in 1875, 1882, and 1883. He was also joint author or contributor of results to many other papers, chiefly on the chemical composition of minerals. His important memoir on the Cranbourne, Rowton, and Middlesbrough meteorites was read before the Royal Society in 1882, and he was elected a Fellow in the following year.

In 1884 he was seized by illness which prostrated his mental powers, and rendered it needful for him to resign his appointment in the British Museum in June last, and notwithstanding every care which medical skill or affection of friends could devise, he succumbed on November 4, leaving a wife and three young children to deplore his early loss.

ON RADIATION OF HEAT FROM THE SAME SURFACE AT DIFFERENT TEMPERATURES

FOR some time past I have been engaged in experimenting on the radiation of heat from the surfaces of wires in air and in vacuum, and I have obtained results which have been partially communicated in papers to the Royal Society (1884) and to the British Association at its last two meetings. I am at present preparing to publish further determinations of emissivities in absolute measure. In the meantime, however, I have obtained a result of some importance which may be of interest to the readers of NATURE.

Stefan has given a law, which is well known, as to the dependence on temperature of radiation of heat from the same surface—namely, that the radiation is in proportion to the fourth power of the absolute temperature. This law was deduced originally from certain experiments of Prof. Tyndall on radiation from a heated platinum spiral (*Pogg. Ann.*, Bd. cxxiv., quoted by Wüllner, "Exp. Physik," Bd. iii. 1885). The law has been also considered by other writers, including Christiansen (*Ann. der Physik und Chemie*, Bd. xix. 1883), and they have adduced experiments which seemed to them to confirm it.

The method of experimenting which I employ makes it easy to test the truth of such a law, and in fact to find the law, and I have accordingly made the necessary calculations for the former purpose.

In my experiments a current of known strength is passed through the wire under examination, and the increase in the resistance of the wire due to heating by the current is determined while the current is passing through it. When the temperature of the wire has become constant, the heat generated by the current (which can be calculated in absolute measure) must be equal to that emitted by the surface of the wire *plus* that lost at the ends of the wire by conduction. The temperature of the wire at the moment is also ascertained from its resistance (as was done by Siemens in his experiments on resistance of platinum wire at different temperatures, *Proc.R.S.*, vol. xix. p. 443). I have recently been experimenting on platinum wires in a high vacuum down to about 1/20 **M**. (one twenty-millionth of an atmosphere), as was described to the British Association at its meeting at Aberdeen.

The results quoted in Table I. below were obtained with a straight platinum wire about half a metre long, 0·04 cm. in diameter. It was contained in a glass tube about 0·6 cm. in internal diameter, and was sealed into the tube at the two ends, the exhaustion being made by a small side tube. The exhaustion at the time of the experiment, as measured by a McLeod gauge, was 1/15 **M**. The temperature of the room during the experiment was 15° C.

The following two tables show the results of the experiment, and also a comparison of these results with the increase of emissivity with absolute temperature calculated according to Stefan's supposed law. Four cases have been taken which are numbered in the first column of each table. For these the current, C, and the resistance of the platinum wire, R, as found by experiment, are given in the second and third columns of Table I. The energy lost by the wire, C^2R, called e in Table II., and the estimated temperature Centigrade are given in the fourth and fifth columns of Table I. The temperature of the surroundings at the time of the experiment was 15° C. In the second table, the second, third, and fourth columns show the absolute temperatures of the wire and surroundings, and the energy lost, e, or C^2R. Column 5 shows the ratios of the energy lost in the several cases to that lost in Case 1, taken as unity. According to Stefan's law the heat emitted from the wire ought to be given by

$$W = A(S^4 - T^4),$$

where S is the absolute temperature of the wire, and T that of the surroundings. Hence if S_1, T_1 denote those temperatures in Case No. 1, and if the heat emitted in this case be taken as unity, the heat emitted with any other temperatures, S and T, would be

$$\frac{S^4 - T^4}{S_1^4 - T_1^4}.$$

This ratio, for the temperatures of the several cases, is given in the sixth column of Table II.; and it will be seen by comparison with Column 5 of that table that the increase of loss of heat with increase of temperature does not follow any such exceedingly rapid law.

TABLE I.—*Results of Experiment*

Case	Current C	Resistance R	Energy emitted C^2R	Temperature, Centigrade °	Condition of wire
1	1 × 0·169	1·087	1·087	25	
2	2·2 × ·169	1·371	6·636	110	
3	6 × ·169	2·17	78·12	525*	Wire perceptibly red in the dark
4	6·5 × ·169	2·32	98·06	550	Wire distinctly red hot

* Temperature 525° taken according to Draper's estimate of temperature of a body just visible in the dark.

TABLE II.—*Comparison of Experimental Results with Calculation in accordance with Stefan's Law*

Case	Absolute temperature of wire (S)	Absolute temperature of surroundings (T)	Energy emitted (e)	Ratio e/e_1	Ratio $\frac{S^4 - T^4}{S_1^4 - T_1^4}$
1	298	288	1·087	1	1
2	383	,,	6·636	6·1	16
3	798	,,	78·12	71·9	438·8
4	823	,,	98·0	90·2	499·8

A comparison between the last two columns shows the enormous discrepancy between the results calculated from Stefan's law and those obtained by experiment.

I am now waiting for the use of a secondary battery, which I expect to have in a very short time, to determine the ratio between the energy lost at dull red heat, say 550° C., and that lost at bright white heat (1200° C. according to Draper), for the case of an incandescent lamp. Already, however, we know enough of the behaviour of incandescent lamps—for example, in the case of an eight-horse-power gas-engine, developing five-horse-power of electric energy, and feeding 50 sixteen-candle-power lamps—to be able to say that it does not require ten times as much work to keep the lamps at white heat as it does to keep them at dull red heat.

November 16 J. T. BOTTOMLEY

ELLIPTIC SPACE

ELLIPTIC geometry is more general than ordinary geometry. It refers to a three-dimensional space of a more general type than ordinary space. The ordinary mathematics supposes a more or less plausible assumption or axiom which reduces elliptic space to a special type. The present little paper is intended to illustrate the unartificial character of the elliptic geometry and to indicate the analytical nature of the axiom which the Euclidian geometry requires us to introduce. We investigate the *measurement of distance* on which the theory of elliptic space chiefly depends.

It is requisite to observe carefully the definitions which are made, and to refrain from the introduction of any notions not explicitly conveyed by the definition. Let us consider a "point" whose co-ordinates are x_1, x_2, x_3, x_4. It is not necessary to think of these co-ordinates as related to any geometrical scaffolding of tetrahedra or the like. It is in fact desirable to attach no geometrical import to the words, and merely to think of the word "point" as implying the four magnitudes just written. A second "point," y, will be similarly denoted by $y_1\ y_2$, y_3, y_4, and we *define* that the point x is distinct from y, unless in the case where

$$\frac{x_1}{y_1} = \frac{x_2}{y_2} = \frac{x_3}{y_3} = \frac{x_4}{y_4}.$$

If λ be a numerical magnitude

$$x_1 + \lambda y_1,\ x_2 + \lambda y_2,\ x_3 + \lambda y_3,\ x_4 + \lambda y_4$$

will also denote a point, and then, it being assumed that x and y are distinct, we have a multitude of points corresponding to the various values of λ. This series we call a "straight line." But we here make no implication of any geometrical character attached to the line. It is merely a collocation of points, where each point is a group of four symbols and nothing more.

Each point on the line is thus correlated with a specific value of the numerical magnitude λ, and thus if we have two points we may refer to them as the points λ and μ respectively.

As we are free from any geometrical meaning of our symbols, we can only introduce the expression "distance between two points" by defining precisely what is meant. The distance will be a function of λ and μ, whose form is to be decided by the properties which we desire to attribute to it. We may therefore select certain laws which we desire this function shall obey, and then discover what function will satisfy the conditions necessary.

We may take a hint from our familiar geometry as to the conditions to be imposed upon the distance function. If A, B, C be three points upon a straight line, then there is no more fundamental notion of distance than that implied in the equation

$$AB + BC = AC.$$

We shall accordingly insist that our distance function shall be obedient to this law (which we may call Law I.). If, therefore, λ, μ, ν be three points upon our straight line, and if $f(\lambda, \mu)$ denote the distance from λ to μ, then we find

$$f(\lambda, \mu) + f(\mu, \nu) = f(\lambda, \nu),$$

and as μ must disappear from this equation we have

$$f(\lambda, \mu) = \phi(\lambda) - \phi(\mu).$$

The first step in the construction of an appropriate distance function has thus been taken, but we have still a wide range of indeterminateness, for $\phi(\lambda)$ may of course be any conceivable function of λ. It will therefore be competent for us to select some additional law and to insist upon obedience to it also.

Again we revert to our familiar geometry for a suggestion. In that geometry it is assuredly obvious that the distance between two points cannot be zero unless the two points are coincident. Trite as this condition may appear, it is yet sufficient to clear every trace of indeterminateness from the form of ϕ: we shall term this Law II.

Combining Laws I. and II. it will be easy to show that if P be a point on the line then there can only be one point, Q, on the line at a given distance from P, for, suppose that there was a second point, Q', then we have, by Law I.,

$$PQ + QQ' = PQ';$$

but if PQ be equal to PQ', then

$$QQ' = 0,$$

from which, by Law II., we see that Q and Q' must be identical.

If the point P be defined by λ, and the point Q at a given distance therefrom be defined by μ, then the relation between λ and μ must be of the one-to-one type. The distance given, we must therefore have some equation of the form

$$A\lambda\mu + B\lambda + C\mu + D = 0.$$

Any constant values for A, B, C, D will be consistent with the conditions, but we can without loss of generality simplify this equation. If we make $\lambda = \mu$ we obtain the quadratic

$$A\lambda^2 + (B + C)\lambda + D = 0.$$

We thus see that there are in general two critical points on the line corresponding to the roots of this equation. If we choose these two points for x and y, which is of course possible without sacrifice of generality, the roots of this equation should be 0 and ∞, or in other words the constants A and D must be each zero. We thus see that by an appropriate choice of the fundamental points the relation between λ and μ assumes the simple type

$$B\lambda + C\mu = 0,$$

or, finally,

$$\lambda = h\mu,$$

in which h is a function of the particular distance between λ and μ.

We have, however, seen that the distance is also to be expressed in the form

$$\phi(\lambda) - \phi(\mu).$$

This must therefore be a function of h, that is, of $\lambda \div \mu$, and thus we have

$$\phi(\lambda) - \phi(\mu) = F\left(\frac{\lambda}{\mu}\right).$$

From this equation the particular value of the distance has disappeared. It must therefore be true for all values of λ and all values of μ. It must remain true if differentiated either with respect to λ or μ. We therefore have

$$\phi'(\lambda) = \frac{1}{\mu} F'\left(\frac{\lambda}{\mu}\right)$$

$$-\phi'\mu = -\frac{\lambda}{\mu^2} F'\left(\frac{\lambda}{\mu}\right),$$

whence

$$\lambda\phi'(\lambda) = \mu\phi'(\mu),$$

but as λ and μ are independent this requires

$$\phi'(\lambda) = \frac{H}{\lambda},$$

or

$$\phi(\lambda) = H \log \lambda,$$

whence finally we see that the distance between the two points λ and μ is

$$H \log \frac{\lambda}{\mu},$$

where H is a constant.

There seems nothing arbitrary in this process. We have set out with the two laws I. and II., and we have without any other assumption been conducted to the logarithmic conception of distance which lies at the foundation of the elliptic geometry. We might almost be tempted to ask how any other conception of distance can be reasonable. The two laws assumed are obviously true on any intelligible conception of distance, and yet they conduct to the logarithmic expression and apparently to nothing else.

It remains to show where the assumption made in ordinary geometry comes in. Hitherto we have not restricted the generality of the constants A, B, C, D which enter into the equation between λ and μ. Euclid, however, demands that the expression

$$(B + C)^2 - 4AC$$

shall be equal to zero. This has the effect of rendering the quadratic equation a perfect square. The logarithmic theory is accordingly evanescent, and we have to resort to the specialised conception of ordinary distance.

ROBERT S. BALL

NOTES

THE Council of the Royal Society at their last meeting awarded the Copley Medal to Auguste Kekulé, of Bonn (For. Mem. R.S.), for his researches in organic chemistry, and the Davy Medal to Jean Servais Stas, of Brussels (For. Mem. R.S.), for his researches on the atomic weights. At the same meeting, Prof. D. E. Hughes, F.R.S., and Prof. E. Ray Lankester, F.R.S., were nominated for the Royal Medals—the former eminent for his electric researches, and the latter for his services to embryology and animal morphology. Her Majesty has since signified her approval of these nominations.

THE anniversary meeting and annual dinner of the Royal Society will take place on Monday next—St. Andrew's Day.

THE session of the Society of Arts was commenced on Wednesday last by a most important address by the President, Sir F. Abel, on Appliances used in Mines. We shall give this on a subsequent occasion.

SIR JOSEPH HOOKER, we learn, retires, after a tenure of twenty years, from the Directorship of Kew Gardens on the 30th of the present month.

THE Savilian Professor of Geometry, J. J. Sylvester, M.A., Hon. D.C.L., proposes to deliver a public lecture on Saturday, December 12, at 4.45 p.m., in the Mathematical Lecture Room in the University Museum, Oxford, "On a General Theory of the Necessary Singularities of Curves of Unspecified Order." The lecture, although presupposing some elementary knowledge of modern algebra, will not go into details of calculation, but will have for its principal object to bring to light the existence of a new world of algebraical forms, co-ordinate in extent and parallel in character, genesis, and laws of association with those which occur in the theory of invariants.

WE hear with regret that there is a possibility of the *Zoological Record* being discontinued after the close of the next (the 21st) annual volume, unless additional support be received from those most intimately concerned in the welfare of this useful and (to zoologists) indispensable *résumé* of the work done in each year. It will be a standing disgrace to British, Colonial, and American zoologists, if they allow the *Record* to lapse on attaining its majority. Those who have worked with it cannot but acknowledge the aid it has afforded them; those who work without it run the risk of finding themselves anticipated. There are probably many local societies, public libraries, institutions, and private individuals that have not yet supported it, but should do so. The *Zoological Record* Association consists of members and subscribers. Members render themselves liable to the extent of 5*l.*, and on the exhaustion of this sum can withdraw or renew their membership. They receive the annual volume, and the average cost to them has at present amounted to about 24*s.* Subscribers pay annually 1*l.*, for which they receive the volume, and incur no further liability. All those who are interested in the continuance of our *Zoological Record*, and who are not already amongst its supporters, should lose no time in communicating with the Secretary of the *Zoological Record* Association, Mr. H. T. Stainton, F.R.S., Mountsfield, Lewisham, London, S.E.

THE Elizabeth Thompson Science Fund, which has been established by Mrs. Elizabeth Thompson, of Stamford, Connecticut, "for the advancement and prosecution of scientific research in its broadest sense," now amounts to $25,000. As the income is already available, the trustees desire to receive applications for appropriations in aid of scientific work. This endowment is not for the benefit of any one department of science, but it is the intention of the trustees to give the preference to those investigations, *not already otherwise provided for*, which have for their object the advancement of human knowledge, or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Applications for assistance from this fund should be accompanied by a full statement of the nature of the investigation, of the conditions under which it is to be prosecuted, and of the manner in which the appropriation asked for is to be expended. The applications should be forwarded to the Secretary of the Board of Trustees, Dr. C. S. Minot, 25, Mount Vernon Street, Boston, Mass., U.S.A. The first grant will probably be made early in January, 1886.

LA Société de Physique et d'Histoire naturelle de Genève offers a prize of 500 francs for the best unpublished monograph on a class or family of plants. The prize was founded by A. P. de Candolle. Manuscripts may be written in Latin, French, German (in Roman letters), English, or Italian, and should be sent in to the President of the Society before October 1, 1889, to the Athenæum, Geneva. Members of the Society are not permitted to compete, and the prize may be reduced, or not awarded at all, in the event of the essays being insufficient, or not conforming to these rules. The Society hope to be able to give the successful monograph a place in their *Transactions*, should that mode of publication be agreeable to the author.

TELEGRAMS from Madrid state that earthquake shocks have again occurred at Velez Malaga, on the coast of the province of Malaga. There appears also to be some seismic movement on the opposite African coast, producing landslips of considerable magnitude close to the Mediterranean, while the bed of the sea at the points affected is reported to have sensibly risen. There have also been sharp shocks of earthquake in Andalusia, especially at Alhama, which suffered so much last year.

DR. FOREL writes that the following shocks of earthquake have been observed in Western Switzerland:—November 15, 2h. 15m. a.m., at Sion, Gryon, Ollon, or the same region which was affected on September 26 last; November 18, 9h. 25m. p.m., Chevroux, south-east bank of Lake Neuchâtel; November 20, 5h. 45m. a.m., at Gondo, on the south face of the Simplon.

SEVERAL great earthquake waves from the Pacific were observed at San Francisco on November 19 between 1 and 8 o'clock p.m. at intervals of thirty-five minutes.

BRIGADE-SURGEON AITCHISON, the naturalist with the Afghan Boundary Commission, arrived in England on the 23rd inst. He brought his numerous collections with him as far as Batoum, and there shipped them on an English steamer for London. He has succeeded in obtaining a very fine specimen of a tiger from Turkestan, which, if it should reach England alive, will be unique of its kind, as no living specimen of this animal from those districts has as yet been brought to Europe.

CAPT. MANGIN, the inventor of the system of optical telegraphy as now practised in the French Army, has died suddenly from an attack of apoplexy at the early age of forty-five.

THE committee for erecting a statue in commemoration of the late Dr. Broca has opened a public competition for this monument.

THE French Minister of War has granted new credits to the Meudon aëronauts for the construction of a larger balloon. Workmen are enlarging the shed for building the apparatus.

M. MENIER, the well-known electrical engineer and contractor, has purchased a large property, rue de Chateaud'un (Paris), and is rebuilding it on a new system. He will sell electric light to all the lodgers in the house at a reasonable rate. It is the first time this speculation has ever been tried in Paris.

WE understand that the Science and Art Department have given their sanction to the exhibits from the Buckland Museum Collection being retained by the South Kensington Aquarium authorities until the close of the Indian and Colonial Exhibition next year. A better position for them could not be found, more especially as the casts of fish hung upon the walls are in *bon accord* with the living specimens in the tanks.

THE Norwegian Forest Association, started in 1881, is making very good progress. At present there are about 250 members. The Association's journal for the current year, embracing some 300 pages, contains a number of important papers by the most eminent Norwegian writers on the subject of forests and forest culture. A meeting for the discussion of important subjects takes place annually. The question of preserving the old and cultivating new forests appears to be coming more and more to the front in Scandinavia, where the Government has now established several schools with plantations for the cultivation of young plants. In Sweden the children of the rural Board-schools are often employed on fine days in planting out young trees. Thus during last summer some thousand acres have been planted in a single parish alone. Of late years private individuals too have done a great deal to retrieve the deforestation which has been going on by planting new trees. In one single parish in Norway, for instance, a proprietor has planted on waste land no less than a quarter of a million of spruce, fir, and larch trees, all obtained from the Government nursery. The price of the young plants is one farthing, and only 10 per cent. of the plants die. After thirty years each is valued at 7*d*. in the ground. These are of course valuations in a country where both labour and timber are cheap.

WE learn that Dr. J. G. Garson has just been elected a Corresponding Member of the Anthropological Society of Paris.

As a memorial to the late Sir Titus Salt, and in recognition of his benefactions to Saltaire, the Governors of the Salt Schools have decided to build a new Science and Art School, costing about 6000*l*. The building will be completely finished by May 15, on which day will be opened an important exhibition on the lines of the late International Inventions Exhibition. For this purpose the present buildings and a field of six acres will be utilised. The arrangement and supervision of the lighting and other electrical work have been intrusted to Messrs. Woodhouse and Rawson, of London.

IN the last number of the *Bulletin* of the American Geographical Society, Mr. Ernest Ingersoll publishes a paper on the manner in which the settlement of North America has affected its wild animals. He takes in succession the customary divisions of animal life—mammals, birds, reptiles, fishes, and the almost countless invertebrates, and shows how far these prevailed geographically in historical times, and how they have now either disappeared altogether, or been driven northwards into the Canadian forests, or, in the case of fish, away from the coasts. Mr. Ingersoll thus ranges over the whole animal kingdom, and in every department he has to record destruction—in many cases wanton and useless—and disappearance. It is a most instructive and interesting paper.

THE Sanitary Institute of Great Britain has just completed the preparation of a volume which will be of great interest to the statistical world, containing selections from the reports and writings of the late Dr. W. Farr. The selection of the papers and reports and the editing of this work have been undertaken by Mr. Noel A. Humphreys, of the Registrar-General's Office. The volume consists of 550 pages and is divided into six parts: (1) population, (2) marriage, (3) births, (4) deaths, (5) life tables, (6) miscellaneous. It has long been the source of much regret among students of vital statistics, and others practically interested in that branch of sanitary science, that from the form and manner of the publication of Dr. Farr's valuable papers on statistics they have not been generally available, being scattered over a long series of Blue-Books and other Reports. The object of the Institute in publishing the selection is to give those interested in the subject a ready means of studying the valuable writings and tables of that eminent statistician.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mrs. Berry; two Black-eared Marmosets (*Hapale penicillata*) from South-East Brazil, presented by Miss L. M. Graham; two Emus (*Dromæus novæ-hollandiæ*) from Australia, presented by Lord Northesk; an Emu (*Dromæus novæ-hollandiæ*) from Australia, presented by Mr. A. Garrett Smith; a Cuvier's Podargus (*Podargus cuvieri*) from Australia, presented by Mr. Cromwell Collins; a Tawny Owl (*Syrnium aluco*), British, presented by Mr. Phillips; an Anaconda (*Eunectes murinus*) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Robben Island Snake (*Coronella phocarum*), a Hoary Snake (*Coronella cana*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.

OUR ASTRONOMICAL COLUMN

THE FRENCH PHOTOGRAPHS OF THE TRANSIT OF VENUS.—The measurement of the 700 photographs obtained at the various French stations during the transit of Venus, 1882, is about to be commenced. An office has been organised for the purpose, the necessary credit has been granted, and a measuring instrument, belonging to the Meudon Observatory and lent by M. Janssen, has been supplied. This will be replaced in January next by a smaller one by the same makers, MM. Brunner, Frères. The measurements, it is expected, will be completed in fifteen months.

THE ABSORPTION-SPECTRUM OF OXYGEN.—M. Janssen, continuing at the Meudon Observatory his important and difficult researches on the spectra of the gaseous constituents of the terrestrial atmosphere, has recently given (*Comptes rendus*, vol. ci. No. 14) a brief notice of the results he has obtained. The spectrum of an intensely brilliant light is viewed through a tube 60 m. in length containing oxygen, the pressure of the gas being constantly increased up to a pressure of 27 atmospheres. With the increase of pressure, dark lines or groups of lines appear. The first to appear are those groups in the red, which M. Egoroff, who was the first to observe them, considered to be the A and B of the solar spectrum. With higher pressures, and a more brilliant source of light, lines are suspected between A and B and between B and C. Lastly, with the greatest pressures three dark bands appear; one near *a*, one near D, but more refrangible, and one in the blue. The solar spectrum does not show any similar bands, which, therefore, can scarcely be ascribed to oxygen in the state in which it exists in our atmosphere.

THE APPARENT ENLARGEMENT OF CELESTIAL OBJECTS NEAR THE HORIZON.—M. Paul Stroobant has recently devoted a considerable amount of care to examining the cause of this well-known phenomenon. His experiences lead him to reject the theories most commonly received, that the appearance is due either to comparison with terrestrial objects, or to the "flattened arch" shape ascribed to the celestial vault. Experiments made with pairs of electric sparks in a lofty hall, showed that if the two sparks overhead were 100 mm. apart, the pair on a level with the eye, and equally distant from the observer, needed only to be 81·5 mm. apart to seem separated to a similar extent. Comparisons of various pairs of stars gave a similar result, and the following formula was found to represent the apparent size, G, of a celestial object, at any given altitude, H, when the size on the horizon was taken as 100:—

$$G = 100 - 19 \sin H.$$

Beside this relation, depending evidently on some physiological effect connected with the position of the head, M. Stroobant found that an increase in the brightness of an object caused an apparent diminution in its size, and *vice versâ*. The great apparent size of the moon at rising was therefore, he considered, largely due to its comparative faintness when near the horizon.

NOVA ANDROMEDÆ AND ITS RELATION TO THE GREAT NEBULA.—There seems to be considerable difference of opinion as to whether the new star is to be regarded as having a real physical connection with the nebula, or as being connected with it in appearance only. M. Trouvelot (*Comptes rendus*, vol. ci. No. 17) ably pleads for the latter view. Comparing the present aspect of the nebula with the chart he made of it in 1874, he finds two new stars in the central district, one being the present *Nova*, the other a star of the 13th or 14th magnitude, which precedes it by about 20s. But he believes that the nebula itself has undergone no change during the appearance of the *Nova*, the impressions to the contrary being, he thinks, due to the superior light of the star having overpowered for a time the surrounding portions of the nebula; so that the arguments founded upon these supposed or apparent changes lose their force. The 1874 chart shows some 1283 little stars, which by their feebleness and crowding present the characteristic features of the Milky Way, which indeed appears to extend somewhat beyond the nebula; and these stars also appear to become less and less numerous the farther the observer travels from the Milky Way.

But none of the stars visible upon the nebula show diffused or ill-defined borders; so that they are probably neither in the nebula nor behind it, but before it, and forming part of the Milky Way. And as the two new stars alluded to are also well and clearly defined, he argues that they also are connected with the Milky Way, and not with the nebula, which he regards as lying behind it.

THE NICE OBSERVATORY.—The great objective of 30 inches diameter, intended for the Nice Observatory, and the glass for which was supplied by M. Feil, has just been completed by the Brothers Henry, and has been placed in the hands of M. Gautier, who is constructing the equatorial, which he hopes to finish by April next.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *NOVEMBER* 29 *TO DECEMBER* 5

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 29

Sun rises, 7h. 43m.; souths, 11h. 48m. 35·7s.; sets, 15h. 54m.; decl. on meridian, 21° 34′ S.: Sidereal Time at Sunset, 20h. 29m.

Moon (at Last Quarter) rises, 23h. 16m.*; souths, 6h. 9m.; sets, 12h. 49m.; decl. on meridian, 6° 58′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	9 45	13 20	16 55	25 47 S.
Venus	11 25	15 14	19 3	23 56 S.
Mars	23 22*	6 16	13 10	9 49 N.
Jupiter	1 31	7 36	13 41	0 16 N.
Saturn	17 49*	1 58	10 7	22 23 N.

* Indicates that the rising is that of the preceding day.

Occultations of Planet and Star by the Moon

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
1	Uranus	—	5 0	6 9	53 213
3	κ Virginis	4½	4 24	4 56	92 155

Phenomena of Jupiter's Satellites

Nov.	h. m.		Dec.	h. m.	
29	3 23	I. tr. ing.	3	1 53	II. ecl. disap.
29	5 39	I. tr. egr.	3	7 0	II. occ. reap.
30	3 0	I. occ. reap.	4	5 9	III. tr. ing.
			5	2 8	II. tr. egr.
			5	7 3	I. ecl. disap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Nov.	h.	
29	9	Mars in conjunction with and 3° 23′ north of the Moon.
30	23	Jupiter in conjunction with and 0° 20′ north of the Moon.
Dec.		
1	0	Mercury at greatest elongation from the Sun, 21° east.

Variable Stars

Star	R.A. h. m. s.	Decl. ° ′	Epoch h. m.	Phase
U Cephei	0 52 8	81 15·3 N.	Nov. 29, 3 27	*m*
			Dec. 4, 3 7	*m*
Algol	3 0 41	40 30·7 N.	Nov. 29, 5 20	*m*
			Dec. 2, 2 9	*m*
			,, 4, 22 58	*m*
λ Tauri	3 54 19	12 9·9 N.	Dec. 1, 20 9	*m*
			,, 5, 19 1	*m*
η Aquilæ	19 46 37	0 42·7 N.	Nov. 30, 2 30	*M*
			Dec. 4, 21 30	*m*
δ Cephei	22 24 54	57 49·6 N.	Nov. 30, 1 0	*m*

M signifies maximum; *m* minimum.

The spectrum of R Andromedæ R.A. 0h. 17m. 58s., Decl. 37° 56′·4 N. deserves attention. The star is now approaching its maximum.

The following circular has been sent out from Lord Crawford's Observatory, Dun Echt:—"Considering the great uncertainty which envelopes the fate of Biela's comet, it seems desirable to call to mind that about midnight on the 27th inst. the earth will be in the path of the meteors seen to radiate from near γ Andromedæ on November 27, 1872. The comet's periodic time, and presumably that of the meteors being about 6·6 years, nearly two periods will have elapsed since the meteoric shower of 1872. If, therefore, the meteors are very widely distributed along the comet's orbit, there is a chance that they may again appear in considerable numbers this year. In 1892, and still more in 1905, there is a probability of a return of the display of 1872.

GEOGRAPHICAL NOTES

LIEUT. GREELY has been lecturing in Scotland on the Arctic Expedition of which he was the commander. At Dundee, on Monday night, having described the retreat from Discovery Harbour, Lady Franklin Bay, he went on to speak of the results of the Expedition, which could be done only in a general manner. The temperature observations, he remarked, were mainly important in determining the fact that Grinnell Land had the lowest mean temperature in the globe, about 4° F., or 20° C. below zero. This was in accordance with their expectations. The tidal observations, only roughly reduced by him at Conger, confirmed the work of 1875-76, but a large number of simultaneous readings at seven special stations in the Polar Sea, Robeson and Kennedy Channels, should enable tidal experts to determine quite accurately the shape and direction of the tidal wave, an important element in the theoretical determination of the configuration of lands and sea-bottom to the north. In Grinnell Land the discovery of coal not only at various points along the sea-coast, but at others in the interior, proved conclusively the changed climatic condition, as did the fossil forest found near Cape Baird in 81° 30′ N. Discoveries of Eskimo remains were of interest as showing the possible extent of this immigration of a new race into the Polar Basin. The Lieutenant next spoke of geographical discoveries. The furthest point seen by Beaumont was Cape Britannia, nearly 50 miles beyond the extreme point actually attained by that heroic officer. From Britannia Island Lieut. Lockwood and Sergeant Brainard pushed on 100 miles further, and passed a day and a half at Lockwood Island, the furthest point by land or sea ever attained by civilised man, in 83° 24′ N., 40° 46′ W. From an elevation of nearly 3000 feet it was evident that no land existed within a radius of sixty miles to the north or north-westward, but to the north-east the Greenland coast yet trended, ending to the eye at Cape Washington in 83° 35′ N. To Greenland was thus added 125 miles of new coast excluding the fiord lines, and from Cape May the mainland was carried a degree of latitude to the northward. In carrying Greenland 10° of longitude further to the eastward, Lieut. Lockwood left but 16° for his successors to fill in. The new land is composed of high precipitous promontories along the coast, and equally broken country inland, in which but three glaciers were seen, none discharging. It was evident that the inland ice-cap of Greenland stopped far to the southward of the 82nd parallel. In short, there existed from Robeson and Kennedy Channels, westward to Greely Fiord and the Polar Sea, a series of fertile valleys clothed with vegetation of luxuriant growth, whereon were large herds of musk oxen. He desired to say a few words as to his discoveries concerning the much-talked-of palæocrystic ice, especially the floebergs from 100 to 1000 feet thick. The opinion advanced by Sir G. Nares that this ice formed over the Arctic Ocean was not borne out by facts, and he could not commit himself to the judgment that this sea was for ever unnavigable, for they knew that a quantity of the ice changed from year to year, and little of it was seen by Lieut. Lockwood to the northward of Cape May. Dr. Moss was certainly correct as to the universality of stratification in this ancient ice, and he concurred in the opinion that its salinity was due to efflorescence and infiltration. There was no doubt in his mind that these floes were simply detachments of slowly-moving glacial ice-caps from an ice-covered land in the neighbourhood of the Pole. Lieut. Lockwood found small floebergs, perhaps 100 to 200 feet thick, detached from the adjacent ice-caps. In Kane Sea he visited a floeberg a third of a mile wide, a quarter of a mile long, and from a fifth to a sixth of a mile thick. The proof as to its terrestrial origin no one would dispute; on its surface were two valleys about 30 feet deep, along which were the medial moraines of the glacier—fully 100 large stones polished and worn smooth in places by the parent ice. He thought it doubtful whether such an ice-cap increased by more than three or four inches yearly, so that from 3000 to 4000 years might easily have elapsed since the incipient birth of the berg in question. Lieut. Greely advocated future Arctic exploration in the direction of Franz Josef Land.

MR. GAMEL, at whose sole expense the late expedition to the Kara Sea, under Lieut. Hovgaard, was undertaken, intends, provided his enterprise be seconded by the Government, to send his steamer *Dijmphna* next summer on an expedition, under an officer of the Danish Royal Navy, to the east coast of Greenland, to explore and lay down the coast-line between 66°·08, the farthest northward point attained by Capt. Holms's expedition, and 70°.

ACCORDING to the *Gazette Géographique*, M. Moller, who was recently charged with a mission of botanical investigation to the Island of St. Thomas, has returned to Lisbon. He has brought with him a large number of interesting specimens, not only of the botany, but also of the geology, of the island. These have been placed for investigation in the hands of M. Henriques, the Professor of Botany of the Coimbra University. M. Moller has also made some important additions to and corrections in the map of St. Thomas recently published. He has proved that the highest mountain in the island is the Peak of St. Thomas, and that its height is 2142 metres.

AN officer of the French Navy, Commander Réveillère, has succeeded in a daring attempt which he made recently to ascend the rapids of the Meikong, beyond Samboc, in a steamer. Samboc is the chief Cambodian town on the river, and at one time it was thought impossible for a steamer even to reach that point. A short distance above the town commences a series of rapids, which last for about forty miles, and which in parts appear as formidable obstacles to navigation as the cataracts on the Nile. Commander Réveillère, however, succeeded in overcoming them, but only after such exertion and danger as make it clear that in their present state they present an insuperable barrier to navigation for commercial purposes. He proposes a thorough hydrographic study of this section of the river at low water, and he is convinced that the famous barrier will turn out to be merely a mass of trees which has got permanently fixed there and is maintained by annual additions, but which can be removed without difficulty by means of explosives. Beyond the rapids is the town of Stung-Treng, where the greater part of the commerce of the Laos reaches the river, and hence the advantage of a navigable passage. Commander Réveillère concludes his account of his feat by recommending "a serious hydrographic campaign in the rapids of the Meikong, and in the lower Laos." The Meikong is one of the greatest of the great rivers of Asia; it was first thoroughly explored fifteen years ago by a mission under Lagrée and Garnier, which came to the conclusion that this magnificent water-way was useless for trade purposes on account of its rapids.

LIEUT. ALLEN has lately returned to San Francisco from a successful exploration of Alaska, undertaken by direction of the United States Government. He left Sitka in February, going to the mouth of the Copper River, which he ascended as far as the great mountain range of Alaska. He crossed the mountains with snow-shoes, coming to the sources of the Tennah, which river he followed for 800 miles to its junction with the Takon, and he descended this latter river to its mouth, a journey of between 400 and 500 miles. From the mouth of the Takon he went to Fort Michael, on Behring's Straits, whence he came home.

THE proposal that the Netherlands Government should make a grant to the Dutch Geographical Society towards the expenses of the projected scientific expedition for the exploration of the half of New Guinea belonging to Holland has been rejected by the Second Chamber by a large majority, there being forty-nine votes against the motion to twenty-one in favour of it. In the debate most of the speakers expressed their conviction of the desirability of the expedition maintaining the character of a purely private enterprise.

A NEW edition of Dr. Hunter's "Indian Gazetteer of India" in twelve volumes is in the press. Several of the volumes will be published in the course of the next few weeks.

THE November number of the Austrian *Monatsschrift für den Orient* contains a long communication from Dr. Lenz, from Ango-Ango, with reference to his expedition to the Congo. It deals mainly with the superficial aspects of the various settlements on the West Coast of Africa, of the trade there and its future prospects, and especially with the prospects of Austrian trade.

UNDER the title, "La Corée avant les Traités," M. Jametel, a French writer on the Far East, has published, in a *brochure* of about eighty pages, four articles which he contributed to recent numbers of *La Revue de Géographie*. He describes the voyage from Nagasaki to Fusan, a Corean port then only opened to Japanese trade, and gives a sketch of the history of the peninsula from early times; finally he describes the Japanese settlement at Fusan and the neighbouring Corean town of Toraifu, and adds a few words about the Island of Quelpaest. The account is very lively and amusing, but it can hardly be said to add much to our geographical knowledge of Corea, small as that was before the treaties.

CHLOROPHYLL[1]

ALL who are accustomed to observe vegetation must have been struck with the great variety of shades of green which the foliage of different plants presents. Without pretending to generalise further, it may be stated that, at any rate so far as our common agricultural plants are concerned, they show somewhat characteristic shades of colour, according to the *Natural Order* to which they belong—the Leguminosæ differing from the Gramineæ, the Cruciferæ, the Chenopodiaceæ, and so on. But the same description of plant will exhibit very characteristic differences, not only at different stages of growth, but at the same stage in different conditions of luxuriance, as affected by the external conditions of soil, season, manuring, &c., but especially under the influence of different conditions as to manuring.

The Rothamsted field experiments have afforded ample opportunity for observations of this kind; and it has been quite evident that, in a series of comparable experiments with the same crop, depth of green colour by no means necessarily implied a finally greater amount of carbon assimilation; whilst we have long ago experimentally proved that the deeper colour was associated with relatively high percentage of nitrogen in the dry or solid substance of the herbage; and this obviously means a lower relation of carbon to nitrogen.

Mentioning these facts to Dr. W. J. Russell, who has devoted so much attention to the subject of chlorophyll, he kindly undertook to make comparative determinations of the amounts of chlorophyll in parallel specimens, in which we were to determine the percentages of dry matter and of nitrogen. Accordingly in June, 1882, during the period of active vegation, Dr. Russell spent a day at Rothamsted for the purpose of collecting appropriate samples, which were taken from several differently-manured plots of meadow-grass, wheat, barley, and potatoes, respectively.

The following table gives the results of some of these experiments; namely, the percentages of nitrogen, and the relative amounts of chlorophyll, in the separated gramineous and the separated leguminous plants in the mixed herbage of grass-land; in specimens of wheat grown by a purely nitrogenous manure, and by the same nitrogenous manure with a full mineral manure in addition; and in specimens of barley grown by a purely nitrogenous manure, and by a mixture of the same nitrogenous manure and mineral manure in addition. It is to be borne in mind that the specimens were collected while the plants were still quite green and actively growing. It should be further explained that the amounts of chlorophyll recorded are, as stated in the table, relative and not actual; that is to say, the figures show the relative amounts for the individual members of each pair of experiments, and not the comparative amounts as between one set of experiments and another.

It will be seen in the first place that the separated leguminous herbage of hay contained a much higher percentage of nitrogen in its dry substance than the separated gramineous herbage; and that, with the much higher percentage of nitrogen in the leguminous herbage, there was also a much higher proportion of chlorophyll. Under comparable conditions, however, the Leguminosæ eventually maintain a much higher relation of nitrogen to carbon than the Gramineæ; in other words, in their

[1] "Note on some Conditions of the Development, and of the Activity, of Chlorophyll." By Prof. J. H. Gilbert, LL.D., F.R.S. Read in Section B at the meeting of the British Association at Aberdeen, September, 1885. (Abstract.)

case carbon is not assimilated in so large a proportion to the nitrogen taken up.

Next, it is to be observed that the wheat-plants manured with ammonium-salts alone show a much higher percentage of nitrogen than those manured with the same amount of ammonium-salts but with mineral manure in addition. The high proportion of chlorophyll again goes with the high nitrogen percentage; but the last column of the table shows that, with the ammonium-salts without mineral manure, with the high percentage of nitrogen, and the high proportion of chlorophyll, in the dry substance of the green produce, there is eventually a very much less assimilation of carbon. The result is exactly similar in the case of barley; the plants manured with ammonium-salts alone showing the higher percentage of nitrogen, and the higher proportion of chlorophyll, but eventually a much lower assimilation of carbon.

It is evident that the chlorophyll formation has a close connection with the amount of nitrogen assimilated, but that the carbon assimilation is not in proportion to the chlorophyll formed, if there be a relative deficiency of the necessary mineral constituents available. No doubt there has been as much, or more, of both nitrogen assimilated and chlorophyll formed, over a given area, where the mineral as well as the nitrogenous manure had been applied, the lower proportion of both in the dry matter being due to the greater assimilation of carbon, and consequently greater formation of non-nitrogenous substances.

It is of interest to observe that these results of experiments in the field are perfectly consistent with those obtained by vegetable physiologists in the laboratory; they having found that the presence of certain mineral or ash constituents, and especially that of potassium, is essential for the assimilation of carbon, no starch being formed in the grains of chlorophyll without the aid of that substance. Sachs says:—"Potassium is as essential for the assimilating activity of chlorophyll as iron for its production."

Relation between Nitrogen Accumulation, Chlorophyll Formation, and Carbon Assimilation.

The figures in parentheses represent determinations in the not fully dried substance.

	Nitrogen per cent. in dry substance.	Relative amounts of Chlorophyll.	Carbon assimilated per acre per annum.	
			Actual.	Difference.
			lbs.	lbs.
HAY—				
Gramineæ	1·190	0·77		
Leguminosæ	2·478	2·40		
WHEAT—				
Ammonium-salts only	(1·227)	2·00	1,398	−824
Ammonium-salts and mineral manure ...	(0·566)	1·00	2,222	
BARLEY—				
Ammonium-salts only	(1·474)	3·20	1,403	−685
Ammonium-salts and mineral manure ...	(0·792)	1·46	2,088	

CARTOGRAPHICAL WORK IN RUSSIA IN 1884[1]

THE chief surveys in European Russia are directed towards mapping South Finland, the western frontier on the Duna and Dnieper, and the Government of Taurida. The surveys are made on a scale of 1750 feet to the inch, and the inequalities of soil are represented by horizontal lines received from accurate levellings. Since 1870 about 44,000 square miles have been thus mapped, and, in 1884, 6850 square miles were added to the above, the newly-annexed part of Bessarabia included. The geodetical triangulation for this survey was continued in Poland and Grodno. The work for an orographical map of Russia, which must be based on accurate levellings, has been busily continued since 1881, as also telegraphic determinations of longitudes in Poland.

[1] *Izvestia* of the Russian Geographical Society, September, 1885.

Instead of the former map of West and Middle Russia, on 150 sheets, on the scale of 3 versts (2 miles) to an inch, the Topographical Department is now preparing a new map on a larger scale (2 versts to an inch), which will be printed on a new method, by helio-engraving, with level-lines in a separate colour. Many preliminary essays having been made, this method has been definitively adopted. The map of Russia (10 versts to an inch) has been completely revised by General Strelbitzky; and the map of the Caucasus, on the same scale, was completed in 1884. The northern and north-eastern sheets of the map of European Russia will be completely revised in accordance with new surveys.

The map of the Asiatic dominions of the Empire, with the neighbouring regions (100 versts to an inch), is completed, and is printed in colours. That of the eastern part of the Balkan peninsula is prepared on two different scales (5 and 3 versts to the inch), and on both maps the inequalities of the soil are represented by horizontal lines. The middle parts, including the Balkan ridge, were ready to print. Helio-engraving had also been resorted to, but it required considerable retouching by the engraver.

Leaving aside the purely military maps of Middle Europe and the statistical maps of the St. Petersburg military district, the following maps, published in 1884, are especially worthy of notice:—The region of the Cossacks of the Ural (10 versts to an inch); the Island of Sakhalin (40 versts); North-Western Mongolia (50 versts), including all the rich materials collected by the expeditions of MM. Potanin, Rafailoff, Orloff, Prjevalsky, Pevtsoff, and several others; Afghanistan (50 versts), according to the surveys and information of M. Lessar; the south-western Turkoman region, by the same (20 versts); the surveys of M. Kosyakoff in Karategin and Darvaz (15 versts); the survey from Staro-Tsurukhaitu to Aigun, on the Amur (25 versts); a map of China proper, by M. Matusovsky (100 versts); the plans of Odessa, Nikolaieff, Ekaterinoslav, Bendery, and Elizabethgrad, as also of Plevna and Lovtcha; the neighbourhoods of Kazan and of Novogeorgievsk, and many others.

On the Caucasus, as soon as the triangulation of the region was terminated some fifteen years since, a series of surveys, on scales of 1400, 1750, and 3500 feet to an inch, were undertaken. Large parts of Transcaucasia were thus mapped. Since 1881 the work has been prosecuted in the central parts of the great Caucasus ridge, in Daghestan, and in the Transcaspian region; about 30,000 square miles were thus surveyed. In 1884 the chief surveys were made in the teritory of Merv, along the Murghab; and on the routes between Kizil-arvat, Petro-alexandrovsk, Khiva, and Merv. The drawing and engraving of the great map of the Caucasus with the neighbouring parts of Persia and Turkey, as also of that of the Transcaspian region, both on a scale of 5 versts to the inch, have been prosecuted.

In Turkestan the chief attention has been directed towards the survey of the former khanate of Kokan, now the province of Ferghana, the work meeting with great difficulties owing to the hilly character of the region and its unhealthy climate. Reconnoitring has been prosecuted in the vassal khanates of Bokhara, west of the Pamir, by a topographer who accompanied Dr. Regel.

The mapping of the town of Tashkend, which covers as much as thirty-five square miles, and where trigonometrical measurements meet with great difficulties on account of refraction and the want of wood for the triangulation-pyramids, a system known under the name of *Polygonale Züge*, and which has been greatly extended of late in Germany, has been resorted to. The horizontal angles were measured by a little universal instrument, and the distances by a ribbon, with the help of the eclimetre. The results obtained were very satisfactory. Several new sheets of the 10 versts map were printed, as also a map of the neighbourhood of Tashkend.

In the Omsk military district, detailed surveys, based on a geodetical net, have been prosecuted since 1870 to the south-west of the Irtish River, between its sources and Pavlodar. In 1883 and 1884 large spaces in the region between Omsk, Pavlodar, Petropaulovsk, and Kokchetav were mapped, and a series of latitudes and longitudes were determined.

In Eastern Siberia the Government of Irkutsk is now surveyed on a scale of one verst to the inch, the trigonometrical net having been completed in 1882. The upper parts of the Vition and Barguzin were reconnoitred, and the trigonometrical net extended in Southern Transbaikalia. On the Pacific coast, the region east of the Suifun River, and on the Chinese frontier, has been surveyed.

The following maps, published by the Military Commissariat, deserves also a short notice:—A map of European Russia, showing for each government the surplus, or the want of, rye raised within the government, as also its price, which map leads to very interesting geographical conclusions; a map showing the average crops proportionately to the population; and a map of the sheep-breeding in Russia.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The first award of the Smith's Prizes under the new regulations has been made. They are now given to the Bachelors of Arts who send in the best essays on any subject in Mathematics or Natural Philosophy before the end of the Lent Term in the second year after each Mathematical Tripos. Thus the competitors this year took their degree in the Mathematical Tripos of 1883–84. The Smith's Prizes this year are awarded to two essays declared equal in merit, viz. that of Mr. H. E. G. Gallop, Fellow of Trinity College, Second Wrangler in 1883, 1st Division in Part III., 1884, subject, "The Distribution of Electricity on the Circular Disk and Spherical Bowl"; and that of Mr. R. Lachlan, Fellow of Trinity College, 3rd Wrangler, 1883, 1st Division in Part III., 1884, subject "Systems of Circles." It is further announced that the essay by Mr. C. Chree, Fellow of King's College, on "Elastic Solids," and that of Mr. A. N. Whitehead, Fellow of Trinity College, on the "General Equations of Hydrodynamics," deserved honourable mention.

The Special Board for Medicine have reported in favour of the immediate appointment of a Demonstrator of Pathology, with a stipend of 100*l*. a year, to assist Prof. Roy, who now gives systematic lectures three times a week, conducts a practical course for two hours twice a week, and undertakes the autopsies at Addenbrooke's Hospital.

The Chemical Laboratory Syndicate have recommended the acceptance of Messrs. Bull, Sons, and Co.'s tender (Southampton) for 19,300*l*.

The following appointments to Syndicates and Boards have been made:—

Botanic Garden: Messrs. A. H. Cooke and W. Gardiner.
University Library: Prof. A. Macalister.
Museums and Lecture Rooms: Messrs. E. H. Morgan and R. T. Caldwell.
Local Examinations: Mr. J. W. Hicks.
Observatory: Dr. Routh and Mr. J. Larmor.
University Press: Prof. A. Macalister.
State Medicine: Prof. Latham and Dr. D. McAlister.
Mathematics: Dr. Routh.
Physics and Chemistry: Mr. C. Trotter.
Biology and Geology: Mr. W. Gardiner.

Great opposition has been given to the new proposals as to the additional subjects of the Previous Examination required of candidates for honours. As Mr. Oscar Browning said, "dealing with this subject seemed to cast an evil influence over every one who takes it in hand." The fact is the University, containing strong elements attached to and connected with the Public School system, refuses to boldly grasp the nettle and introduce English, Modern Languages, or Physical Science into its schemes for the Ordinary Preliminary Examination, and finds itself consequently in endless difficulties whenever it touches the question.

IN addition to the practical instruction in Biology (Zoology and Botany), in preparation for the Preliminary Scientific and B.Sc. Examinations at the University of London, which we have already announced as being given at Bedford (Ladies') College, York Place, Baker Street, we are informed that a class in Geology and Physical Geography has now been formed, in accordance with the requirements of the University, and that it will be conducted by Miss Mary Forster.

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, November 5.—Dr. Hugo Müller, F.R.S., President, in the chair.—Mr. Leonard de Koningh was admitted a Fellow of the Society.—The following papers were read:—The influence of silicon on the properties of cast-iron, part 2, by Thomas Turner, Assoc. R.S.M.—Modifications of double sulphates, by Spencer Umfreville Pickering, M.A.—The relation of diazobenzene-anilide to amidoazobenzene, by R. J. Friswell and A. Green.—An examination of the phenol constituents of blast-furnace tar obtained by the Alexander and McCosh process at the Gartsherrie Iron Works, part 1, by Watson Smith, J. F. H. Coutts, and H. E. Brothers.—The decomposition of potassium chlorate by heat, by Frank L. Teed, F.C.S. Note on the refractive power of metacinname (metastyrole), by H. G. Madan, M.A., F.C.S.

Zoological Society, November 17.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary exhibited to the meeting two curious Millipedes, believed to be *Spirostreptus annulipes*, which had been sent home from the Cape by Mr. Fisk for the Insect House.—An extract was read from a letter addressed to the Secretary by Major S. W. Yerbury, respecting the exact locality of a Chameleon (*Chamæleon calcarifer*) presented to the Society by that gentleman in June, 1885. Major Yerbury had obtained this specimen near Aden.—Mr. Sclater exhibited and made remarks upon two Newts (*Molge vittata*) transmitted to the Society by Dr. E. B. Dickson, of Constantinople, C.M.Z.S., by whom they had been obtained from Brussa, Asia Minor.—Mr. H. E. Dresser exhibited and made remarks on a female specimen of the Kildeer Plover (*Ægialitis vocifera*), killed, in January, 1885, by Mr. Jenkinson on the Scilly Isles; and a young female Desert-Chat (*Saxicola deserti*) obtained near Spurn Head, Lincolnshire, in October, 1885.—Prof. F. Jeffrey Bell exhibited and gave an account of a specimen of a species of *Balanoglossus* obtained by Mr. Spencer at Herm, Channel Islands, being the first recorded instance of the occurrence of this Hemichordate in any part of the British seas.—Mr. F. E. Beddard read the first of a proposed series of notes on the visceral anatomy of birds. The present paper treated of the so-called omentum of birds and its homologies. It was pointed out that this structure, present in many birds, but apparently absent, or only present in rudiment, in a few others, was represented by a structure having similar relations in the Crocodile, but in no other reptile.—Mr. Oldfield Thomas read a description of *Heterocephalus phillipsi*, an extremely remarkable burrowing Rodent from Somali-land, belonging to a genus of which the only other known species was based upon a single specimen obtained by Rüppell's collector in Schoa. Mr. Thomas considered the affinities of this Rodent to be with *Georychus* and *Bathyergus*.—Mr. Sclater read a paper containing a description of an apparently new species of Tanager of the genus *Calliste*, based on a specimen formerly in the Gould Collection, now in the British Museum. Mr. Sclater proposed to dedicate this bird to its former owner as *Calliste gouldi*.—Mr. Boulenger gave the description of a new frog from Perak, Malacca, which he proposed to name *Megalophrys longipes*.

Physical Society, November 14.—Prof. Guthrie, President, in the chair.—Mr. G. M. Whipple described and demonstrated experimentally the process of testing thermometers at and near the melting-point of mercury, as carried on at Kew. About 20 lbs. of mercury are poured into a wooden bowl and frozen by carbonic-acid-snow and ether; the mercury is stirred with a wooden stirrer, and the snow is added till the experimenter feels, by the resistance to stirring, that the mercury is freezing. The stirring is continued for some time, which causes the mercury to become granular instead of a solid mass. The thermometers are then inserted, together with a standard, and compared. About 100 mercury or 40 spirit thermometers can be thus examined in half an hour, using about 200 gallons of carbonic acid gas compressed sufficiently to form the snow. The bowl, ether, and mercury are cooled first to $-10°$ C. by an ordinary freezing-mixture. The average correction at the melting-point of mercury is now less than 1° F.; when the process was introduced in 1872 it amounted to 5°, but has steadily decreased.—On the electromotive force of certain tin cells, by Mr. E. J. Herroun. Mr. Herroun has examined the electromotive forces of cells in which tin in a solution of its salts was opposed to copper, cadmium, and zinc in solutions of their corresponding salts, the solutions being of equal molecular strengths. The salts used were sulphates, chlorides, and iodides, and the cells were of the ordinary "Daniel" form, with a porous vessel. To prevent the formation of basic salts it was necessary to add a little free acid to the solution of the tin salt, and, to counterbalance the influence of this acid upon the E.M.F. as far as possible, an equal proportion of free acid was added to the other solution. Prof. G. Minchin pointed out the importance of performing these and similar experiments upon tin in the dark, as, by allowing light to fall upon the tin plate, a considerable photo-electric effect would be obtained. Prof. Fleming insisted upon the great importance of temperature corrections in all experiments upon two-fluid cells.—On the law of the electro-magnet and the law of the dynamo, by Prof. S. P. Thompson. It cannot be said up to now that any particular law has been generally accepted, giving the relation between the current in the coils of an electro-magnet and the magnetism induced by it in the core. Many empirical formulæ have been given, most of which are entirely wrong. One, however, recently enunciated by Fröhlich, gives a relation which agrees very closely with observed values. This formula is—

$$m = \frac{i}{a + bi},$$

where m is the magnetic moment of the core, i the current, and a and b constants depending upon the geometrical form of the magnet, and the nature and previous history of the iron core. Fröhlich obtained this relation by experimenting with a series-dynamo. It is purely empirical, but since it agrees so well with the facts as to give values for the magnetism of the core agreeing almost within experimental error with those observed, there is great probability of some law being at its base. And this law Prof. Thompson believes to be one that was stated years ago by Lamont:—"The magnetic permeability varies with the quantity of magnetism the iron is capable of taking up." This may be expressed by the formula—

$$\frac{dm}{di} = k(M - m.)$$

Integrating which and expanding e^{-ki} in powers of i—

$$m = Mki\left\{1 - \frac{ki}{2} + \frac{k^2 i^2}{6} \ . \ . \ . \right\}.$$

Expanding Fröhlich's equation, in powers of i, we get—

$$m = \frac{i}{a}\left\{1 - \frac{bi}{a} + \frac{b^2 i^2}{a^2} - \quad . \right\}.$$

If ki is not great these expressions will coincide in form very closely, and the results lead Prof. Thompson to accept Lamont's expression as being that of a real physical law. Prof. Perry suggested that Lamont's law gave good results from its being an approximation to Weber's theory of induced magnetism, but Prof. Thompson maintained that it represented observed facts better than that theory, which, as developed by Maxwell, shows a decided discontinuity in the process of magnetisation not actually observed. Prof. Fleming remarked upon the similarity of Fröhlich's expression to that for the current through a voltameter; the part $a + bi$ corresponding to the apparent resistance, which may be considered in this case as the resistance to magnetisation of the core-air circuit, and which, like that of the voltameter, varies with the current.

Geological Society, November 4.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Dr. A. G. Nathorst, of Stockholm, was elected a Foreign Correspondent of the Society.—The following communications were read:—On the premaxillaries and scalpriform teeth of a large extinct wombat (*Phascolomys curvirostris*, Ow.), by Sir Richard Owen, K.C.B., F.R.S. The specimen described in this paper is a cast from a fossil discovered in a late exploration of the Wellington bone-caves, and sent to the author with some other casts from the same collection by the authorities of the Australian Museum, Sydney, New South Wales. The fragments in question consist of the premaxillary bones, containing a pair of scalpriform incisors, 160 mm. (6½ inches) long, measured along the outer curve. The teeth and the fragments of bone in which they are implanted were described in detail, and referred to the wombat family. The animal to which they belonged must have been somewhat larger than *Phascolomys medius*, Owen, but less than the type of the sub-genus *Phascolomys*. The specific name is suggested by the chief characters that distinguish the present form from any hitherto known, recent or extinct.—On the structure and classificatory position of some Madreporaria from the secondary strata of England and South Wales, by Prof. P. Martin Duncan, F.R.S. This paper consisted chiefly of a criticism of the conclusions arrived at by Mr. R. F. Tomes in various papers communicated to the Society.—On the *Astrocœniæ* of the Sutton Stone of the Infra-Lias of South Wales, by Prof. P. Martin Duncan, F.R.S.

Anthropological Institute, November 10.—Mr. F. Galton, F.R.S., President, in the chair.—The following elections were announced:—Prince Roland Bonaparte, Hon. Member; Dr. A. Asher, Dr. Alexander Bain, and Messrs. C. F. Clarke, J. W. Crombie, T. H. Edwards, P. Norman, and E. Tregear, as Ordinary Members.—This being the first meeting of the Session, the President made some opening remarks, in the course of which he congratulated the Institute upon the obvious increase of public interest in the science of man. Besides the gratifying facts that more new members are joining the Institute and that the corresponding Section of the British Association was popular, there are such evidences as that the authorities of Trinity College, Cambridge, have extended the tenure of one of their Fellowships to enable its holder to pursue his anthropological studies, and that at the meeting of the British Association at Aberdeen it was the Rector of the University, Dr. Bain, who contributed one of the most thoughtful of the anthropological memoirs. Mr. Galton proceeded to insist upon the political value of anthropology as the science that best qualifies us to sympathise with other races and to regard them as kinsmen rather than as aliens.—A paper containing a short account of some experiments in testing the character of school children as observers, was read by Mrs. Bryant. In these experiments an attempt was made to read signs of character in an observer from the manner in which he makes an observation and describes it as made. From the written description of (1) a room, (2) a picture, which the children experimented upon were first shown and then required to describe, a rough diagnosis of their character as observers can be made, and hence some idea of their character generally is obtained, which, though very deficient in precision and still more deficient in certainty, may have, nevertheless, a real practical value for educational and other purposes. In the experiments made the most interesting points noticed were:—(1) great variety in the proportions existing between the sensational and intellectual factors of perception; (2) the occasional prevalence of the tendency to substitute feeling for thinking, which is a very characteristic feature of general character where it exists; (3) varieties in degree and kind of orderliness; (4) differences in the degree of colour-interest, as also of interest in form and number; (5) great variety in degree and kind of imaginative play, as shown in the efforts of constructive explanation required to describe a picture.—Mr. Joseph Jacobs then read a paper entitled "A Comparative Estimate of Jewish Ability." In it he applied the same method to Jews and Scotchmen as Mr. Galton had applied to Englishmen in his "Hereditary Genius," with results favourable to the two former races in the order mentioned. The subjects in which Jews seemed to show superior ability were philology, music, metaphysics, and finance.

Royal Meteorological Society, November 18.—Mr. R. H. Scott, F.R.S., President, in the chair.—Messrs. T. R. H. Clunn, R. S. Davies, B.A., H. C. Fox, M.R.C.S., W. E. Jackson, J. Richardson, M.Inst.C.E., F.G.S., A. L. Rotch, and C. Todd, C.M.G., were elected Fellows of the Society.—The following papers were read:—The Helm wind of August 19, 1885, by William Marriott, F.R.Met.Soc. This wind is peculiar to the Cross Fell range, Cumberland, and is quite local, but very destructive. The chief features of the phenomenon are the following:—On certain occasions when the wind is from some easterly point, the helm suddenly forms. At first a heavy bank of cloud rests along the Cross Fell range, at times reaching some distance down the western slopes, and at others hovering above the summit; then at a distance of one or two miles from the foot of the Fell there appears a roll of cloud suspended in mid-air and parallel with the helm cloud: this is the helm bar. A cold wind rushes down the sides of the Fell and blows violently till it reaches a spot nearly underneath the helm bar, where it suddenly ceases. The space between the helm cloud and the bar is usually quite clear, blue sky being visible. At times, however, small portions of thin vaporous clouds are seen travelling from the helm cloud to the bar. The bar does not appear to extend further west than the River Eden. The author visited the district in August last, and was fortunate enough to witness a slight helm. He gives a detailed account of what he experienced, and also his observations on the temperature of the air at the summit and base of Cross Fell, the direction and force of the wind, the movement of the clouds, &c.—The typhoon origin of the weather over the British Isles during the second half of October, 1882, by Henry Harries. The author shows, by means of daily charts, that a typhoon which originated near the Philippine Islands on September 27 passed over Japan and the Aleutian Archipelago, entering the United States on October 10. Crossing the Rocky Mountain range, it proceeded through the Northern States and Canada to Labrador and Davis Strait. In the Atlantic it was joined on the 18th by another disturbance which had come up from the Atlantic tropics, the junction of the two being followed by a cessation of progressive movement from the 19th to the 25th. During this period the severe gale which passed along our southern counties on the morning of the 24th was formed, its sudden arrival upsetting the Meteorological Office forecasts of the previous night. Observations are quoted showing that it would have been impossible for the Department to have been aware of its existence before about 3 a.m. of the 24th. Following in the wake of this storm the parent cyclone reached the French coast on the 27th, its advent being marked, as in Japan and America, by violent gales and extensive floods over the whole of Western and Central Europe and Algeria. The village of Grindelwald was destroyed, and in the Austrian Tyrol the damage caused by floods reached at least two millions sterling. Passing through France and the Netherlands the disturbance showed signs of exhaustion, and on November 1, in the Baltic, it quietly dispersed, after accomplishing a journey of over 16,000 miles in thirty-six days. This is the first storm which has been followed day by day from the Pacific to Europe.—Notes as to the principle and working of Jordan's photographic sunshine-recorder, by J. B. Jordan and F. Gaster, F.R.Met.Soc. This instrument consists of a cylindrical dark chamber, on the inside of which is placed a prepared slip of photographic paper. The direct ray of sunlight being admitted into this chamber by small apertures in the side, is received on the sensitised paper, and, travelling over it by reason of the earth's rotation, leaves a distinct trace of chemical action whenever the light is of sufficient intensity to show a definite shadow on a sun-dial. The cylinder is mounted on a stand with adjustments for latitude, &c. The record is fixed by simply immersing it in water for a few minutes. As this instrument records the actinic or chemical rays, it usually shows more sunshine than is obtained by the ordinary "burning" sunshine-recorder.

EDINBURGH

Mathematical Society, November 13.—Mr. George Thom, Vice-President, in the chair.—Sir William Thomson communicated a theorem in determinants, which was read by Dr. Muir. Mr. J. S. Mackay gave an account of the ancient methods for the duplication of the cube.—Mr. William Harvey contributed some geometrical notes.—Mr. A. J. G. Barclay read a paper on physical science in schools.—The following office-bearers were elected:—President: Dr. R. M. Ferguson; Vice-President: Mr. George Thom; Secretary: Mr. A. Y. Fraser; Treasurer: Mr. John Alison; Committee: Messrs. R. E. Allardice, A. J. G. Barclay, W. T. Macdonald, J. S. Mackay, Dr. Thomas Muir, Mr. William Peddie.

PARIS

Academy of Sciences, November 16.—M. Jurien de la Gravière in the chair.—Researches tending to show that the trigemini nerves contain, from the first, vaso-dilatator fibres, by M. Vulpian.—Obituary notice of the late W. B. Carpenter, Corresponding Member for the Section of Zoology, by M. A. Milne-Edwards.—Treatment of the vine by a mixture of lime and sulphate of copper: determination of the distribution of the copper on the plant, and its persistence in the fruit and must, by MM. Millardet and Gayon. From these researches it appears that most of the copper remains deposited on the leaves, the must containing extremely small quantities, and the wine only doubtful traces, or at most 0·1 gramme in 1000 litres.—Letter accompanying the presentation of a new edition of Ptolemy's "Optics," by M. Gilbert Govi.—On the irregular integrals of linear equations, by M. H. Poincaré.—Dynamic effects produced by the passage of locomotive and carriage wheels at the junction of the rails, by M. A. Considère. It is shown that these effects constitute a new and important element in estimating the wear and tear of traffic on the metals of railways. Several experiments show that they are much more serious at the points of contact of the rails than had hitherto been supposed.—On the tension of saturated vapours, by M. E. Sarrau.—Theory of refrigerating mixtures, by M. A. Potier.—Theory of the flow of gases: adiabatic lines, by M. Marcellin Langlois.—On the theory of the receptor electro-magnetic telephone, by M. E. Mercadier.—Description of a new spectroscopic optometer, by M. Ch. V. Zenger. Besides its use in spectroscopic studies, this ingenious little instrument is expected to render great services to physiologists in determining the defective achromatism of the human eye and its variations with age.—Spectroscopic study of the flames of blast furnaces and of the Bessemer process, by M. Ch. V. Zenger.—On the numerical laws of the chemical equilibria, by M. H. Le Chatelier.—Fixation of free atmospheric nitrogen in cultivated ground, by M. H. Joulie.—Note on the physiological action of safranine, and of the crystallised sulfo de fuchsine used in colouring wines, by MM. P. Cazeneuve and R. Lépine. From various experiments made on dogs, pigs, and human subjects, the authors conclude that the fuchsine is a perfectly harmless substance without physiological or therapeutic interest, whereas safranine gives rises to serious toxic phenomena when injected into the veins in a solution of salt water containing 7 per cent. of this substance.—Note on the zymotic properties of charbon and some other kinds of virus, by M. S. Arloing.—Researches on the comparative anatomy of the chord of the tympanum in birds, by M. L. Magnien.—Note on the nerve centres of the cephalopods, by M. Vialleton.—Influence of the number of individuals in the same vessel, and of the form of the vessel on the development of the larvæ of the frog (*Rana esculenta*), by M. E. Yung. The author finds that the rapidity of development is in inverse ratio to the number of tadpoles in the vase, although the supply of food may be superabundant; also that the development is the more rapid the larger the diameter (and consequently of the surface exposed to the air) of the vessels.—Note on the respiration of leaves in the dark, by MM. Dehérain and Maquenne.—On the variations presented by the composition of the gases in the foliage of plants growing in the air, by M. J. Peyron.—Note on the floral polymorphism of aquatic ranunculi, by M. Louis Crié.—A study of the Quaternary deposits in the district of Perreux, east of Paris, by M. Emile Rivière.—Note on an experiment undertaken to determine the direction of the Atlantic currents, by the Prince of Monaco.—Observation of the crepuscular lights on November 2 and 16, in Paris, by M. A. Boillot.

BERLIN

Physical Society, October 23.—Prof. Neesen reported on the experiments he had made on sounding air columns, with the object of determining the relation of Kundt's dust-figures to the tone-pitch. By means of an electric tuning-fork, whose tone-pitch, through the imposition of weights, might be variously modified, the air was maintained in permanent vibration in a glass tube closed at the bottom by a membrane, and the intervals of the sand-ribs from each other measured. To further extend the scale of tone-pitches, rubbed pieces of wood were utilised as sources of sound. The very numerous measurements taken led to a negative result, no relation of the intervals of the ribs from each other to the tone-pitch could be established. On the other hand, however, the speaker succeeded in making some interesting observations of a different kind and prosecuting them to an important stage. He first established that the long-known wandering of the ribs in a permanently sounding tube stood in no demonstrable relation to the vibrations of the air, and in one and the same tube was found at one place directed one way, and at another place another way. Herr Dworzak's presentation of the matter, that this wandering of the ribs was induced by air-currents setting in at the wall of the tube in one direction, and at the middle in another, the speaker was unable to confirm. The cause of the wandering of the ribs could not be ascertained. On the subject of the origin of the ribs several observations had been made, at spots in the tube, namely, where the wanderings of the ribs issued in contrary directions, and where, accordingly, comparative rest obtained. Here, first, a cork sand granule was seen executing movements hither and thither, in which, shortly, ever more and more granules, and at last a whole series, took part. This layer of granules next began to roll up towards the sides, growing ever thicker in the process, and ending in the formation of a rib. The ribs further showed elevations of a character like to that of waterspouts, the branches of which, falling downwards, assumed the shape of whirls, and returned to the rib. On viewing them with intermittent light, these formations appeared at rest, when the number of light intermissions corresponded with the number of vibrations of the exciting sound. A very interesting phenomenon was observed on taking the measurements of pressure in the sounding-tube. A narrow glass tube, open on both sides, with an oil index, the movements of which were observed, served as manometer. No displacement of the index was ever noticed, but out of the interior end of the manometrical tube there appeared to issue a current of air impelling the cork sand a long way. This current of air was stronger when the mouth of the narrow tube was conical than when it was cylindrical. The current of air was present both when the upper end of the tube was open and when it was closed, as also when the lower end turned towards the source of sound was diverted from it, in consequence of an incurvation. The current of air was finally identified at all points of the sounding-air column, but the intensity of the apparent air-current varied according as the lower end was in the belly or in the node of the tube, and according to its length. The maxima of the current were more pronounced than the minima. If the upper end were likewise in the sounding-tube, then was there a current from the manometrical tube forthcoming. The index in the manometer, however, remained persistently unmoved, a demonstration that in point of fact there was no actual current in the narrow tube. The strength of the apparent air-current might be measured by little mills, and when small radiometers with paper wings were introduced into the sounding-tube, they fell into very lively rotation. If instead of full paper wings the radiometers had small conical paper tubes, directed all alike, they rotated just as fast, and in just the same manner as did the other radiometers. When, however, one approached the node of the sounding-tube, the rotation became slower, ceased, assumed the contrary direction, in order, after further progress, to pause again, and next pass into the former lively rotation. The fast rotation of the sound radiometers Prof. Neesen explained as anemometrical movements which, as was known, were independent of the direction of the wind. The contrary movement of the tube radiometers in the node were explained as determined by the currents of air in the little tubes which had been observed in the manometers as stated above; they entered into the phenomena in which the vibratory movements were less. The attractions and repulsions produced by the sound appear to be based on similar processes.

Meteorological Society, November 3.—With reference to a recent publication of Dr. Lender, Prof. Spörer made some observations regarding the line of demarcation which must be drawn between meteorology and hygiene, and by way of illustration related a number of personal experiences gathered in the course of his stay in the tropics, pointing out how the explanation of them did not properly belong to the office of meteorology.—A paper on the brown ring and the solar eclipses, by Dr. Zenker, who was unable to be present, was read. The abnormal sunset glows which had appeared in the skies since the autumn of 1883 and the brown-red ring round the sun were still visible, though in reduced intensity. The fact that these phenomena were not earlier observed showed that they owed their existence to something novel which had been introduced into the atmosphere, and were not at all due to the presence of ice-crystals or globules of fog in the higher strata of the air. The fine particles giving rise to the reflex-phenomena in question might be of terrestrial or of cosmic origin. The first of these two assumptions had to contend with the facts that the dust concerned with the phenomena kept so long afloat that the constituent dust-particles were of a very different character from that of the Krakatão ashes, and that it was at very great altitudes that they appeared to be suspended. Against the second of these assumptions—that, namely, of their cosmic origin—there was the fact of the absence of metallic particles from the dust and also the fact that the dust was found occurring likewise in lower strata. No decision had yet been arrived at in the matter, and it was therefore of great importance to determine precisely the altitude of the dust-cloud floating above the earth. The measurements hitherto taken had yielded very different results. In this respect it was a most striking fact that on one and the same day in Steglitz, near Berlin, the height of the reflecting dust was calculated from the glowing phenomena at from 2 to 17 kilometres, while in Dresden the glow was observed the whole night; and that for the end of the astronomical twilight about midnight, on taking a single reflection, the height of the reflecting surface gave itself as equal to 900 kilometres, and, on taking a double reflection, showed a height of from 200 to 300 kilometres. Dr. Zenker suggested that on the occurrence of the next solar eclipses observations of the brown ring be made. For the zone of totality he calculated the formulæ for the exact determination of the height of the dust-cloud. These formulæ were not communicated, because the paper itself would shortly appear in the *Meteorologische Zeitschrift*. It was only briefly mentioned that if during the totality the whole of the brown-red ring were seen, a height of $6r$ would be the result, r being the diameter of the cone of shadow. An exact representation of the total solar eclipse in the year 1886, visible in America, and that of 1887, visible in Europe and Asia, was appended to the paper.—In the discussion which followed the reading of this paper Prof. von Bezold referred to the fact that the brown ring was very difficult of perception in the plain, being not at all visible in Berlin, for example; while even at a slight elevation it could be very beautifully observed. He further advised caution against the assumption that the brilliant sunset phenomena were something entirely new. He himself occasionally observed such phenomena as far back as 1863, though it was formerly not possible to awaken general interest in the spectacle as can now be done. Regarding the brown ring, too, he conjectured that it had been formerly seen, though attention had not been paid to it.

VIENNA

Imperial Academy of Sciences, July 9.—On some experiments made on total reflection and abnormal dispersion, by E. Mach and T. Arbes.—Experiments on electrical double-refraction of liquids, by G. Taumann.—On phenomena of absorption in crystals of zircon, by E. Linschmann.—On a mite (*Tarsonemus intectus*, n.sp.) living on man and corn, by L. Karpelles.—On the epithelium of the mouth of *Salamandra maculata*, by M. Holl.—On the determination of solubility of some salts in water at different temperatures, by G. A. Raupenstrauch.—On the botanical results of Dr. Polak's expedition to Persia in the year 1882, by O. Stapf.—On the development of chlorophyll-corpuscles, by K. Mikosch.—Determination of the orbit of the Kriemhild (242) planet, by N. Herz.—On rotation and precession of a liquid spheroid, by S. Oppenheim.

CONTENTS

THURSDAY, DECEMBER 3, 1885

THE ETIOLOGY OF CHOLERA

THE announcement by Dr. Koch, as chief of the German Cholera Commission, that he had discovered a micro-organism which was not only peculiar to cholera, but which had a causal relation to that disease, was all along felt by many to have been made on insufficient evidence, and in consequence the India Office in 1884 appointed Drs. Klein and Heneage Gibbes to visit Bombay, Calcutta, and other Indian cities, with a view of studying the disease from the micro-pathological point of view. Their report was received early this year, and whilst it supported Koch's statements to the effect that choleraic dejections were generally characterised by the presence of the comma-shaped bacilli which had been described, it distinctly denied many of the assertions which had been made by that observer, and it altogether set aside the notion that the comma-bacillus bore any causative relation to the disease. The point at issue was felt to be of such importance that the India Office somewhat recently appointed a Committee of physicians to consider the report made by Klein and Gibbes, and to advise them on the matter.

The Committee in question do not profess to have done more than to study the subject as it has been dealt with in the several reports issued by Koch, Klein, and Gibbes, and to communicate their views of the merits of the several reports to the India Office. They deal with the contentions of Koch under several headings. Thus, in the first place, they refer to his assertion that the number of comma-shaped organisms in the intestinal tissues and contents is in proportion to the acuteness of the attack, and that these organisms generate within the body a ferment by which the system is poisoned.

As to this, it is admitted by Klein and Gibbes that if all that Koch asserts on this point were correct there would be strong grounds for believing that the comma-bacilli must in some way or other be related to the cholera processes; but their observations are in direct opposition to the assertion made. As regards the intestinal tissues, and notably the mucous membrane, it was found that, in some most acute cases in which the post-mortem examination was conducted as soon as possible—at times in a quarter of an hour—after death, the comma-bacilli were only conspicuous by their absence; and that these organisms were only present in dead tissues, including the mucus flakes. Indeed, it is contended that the comma-bacilli are only putrefactive organisms; and the Committee, having these facts before them, express the opinion that no direct relation exists between the number of comma-shaped organisms and the gravity of the attack.

Another of Koch's contentions is to the effect that the comma-bacilli are not found except in connection with cholera. Now Klein and Gibbes maintain that these bacilli, or some that in morphological respects appear like them, are found in diarrhœa stools, that they have been met with in cases of dysentery and enteric catarrh, and that in other cases they have been found, together with certain putrefactive organisms, in as large numbers as in many cholera stools. And further, Klein has, since the issue of his report, found that by ligaturing a portion of the bowel of a monkey, large numbers of comma-bacilli were produced, and that these have been found, after cultivation, to present the same character as the so-called cholera bacilli. Besides which, Klein has found comma-bacilli, similar in appearance to those found in cholera, to be ordinarily present in various parts of the alimentary tract in health, and as regards some taken from the mouth, he has succeeded in cultivating them, and in demonstrating that their action on the media in which they grow is identical with that of the bacilli found in cases of cholera. And the Committee, whilst not convinced that the absolute identity of the two sets of bacilli has been proved, are inclined to agree with Klein's contention.

The third point examined is Koch's statement that the presence of comma-bacilli in a tank which supplied certain cholera-affected villages in Calcutta with water was, practically, a proof of the causal connection between the organisms and the disease. As to this, Klein and Gibbes report that they, too, examined the water from this tank, and that it revealed undoubted comma-bacilli in every respect identical with those found in choleraic dejecta; they further added that the water had been contaminated with choleraic evacuations, and that, notwithstanding these two conditions, its extensive use by many human beings had not been followed by a single case of cholera. The reporters hence submit that the water did not contain the cholera virus, and that this latter has nothing to do with the comma-bacilli. Similar evidence as to other tanks is also adduced, and it is added that these tank-commas, having been cultivated, are found to be identical with Koch's comma-bacilli. The question as to the existence of any causal connection between comma-bacilli and disease in animals as the result of inoculations is also discussed, and it is regarded as demonstrated that neither the alvine dejections of cholera nor cultivations of isolated comma-bacilli obtained from such dejecta are capable of producing cholera, nor indeed any disease resembling it.

The Committee, therefore, have concluded that, though comma-shaped organisms are ordinarily present in the dejections of cholera patients, they are not found in the blood or in any of the tissues, even when these are examined in a recent condition; that comma-shaped organisms of closely allied morphological appearance are ordinarily present in different parts of the alimentary canal in health, and can be developed there to an unusual extent in diseases characterised by hyper-secretion of the intestine; and that there is no evidence to show that the comma-shaped bacilli found in cholera induce that disease in lower animals or in man.

According to the Committee, we are now much in the same position as we were before Koch's experiments were instituted, in so far as the prevention of cholera is concerned; and Dr. Timothy Lewis, the Secretary to the Committee, and who has had a wide Indian experience in connection with the micro-pathological study of the disease, further points out that there is nothing new in Koch's observations except in so far as an ingenious and beautiful process facilitating the investigation of micro-fungi is concerned. Dr. Lewis asserts, indeed, that he had made hundreds of cultivations of the bacilli in question, and that he had long since arrived at the conclusion that they were identical with some of the minute vibrios which ha[s] so frequently been referred to by former writers as being present in cholera dejecta: the comma being, in short, nothing more than a segment of one of these vibrios which had become detached during the process used by Koch. It is true that Koch's friends deny that any comma found elsewhere than in the cholera intestine grows under cultivation, in the same way as the one he has described, but so far, this is a mere assertion, not a proved fact; and it is evident that we are but at the commencement of any proper apprehension as to the significance of these vibrios. This is pointed out in an appendix to the Committee's report, and the lines of future investigation into the subject are laid down. But for the present the prevention of cholera can only be found in the prosecution of well-advised sanitary measures, and whilst it is of the utmost importance that labours such as Koch and former investigators have carried out should be continued and put to the most rigid test, yet micro-pathology cannot, at present, be regarded as having made more than a small advance towards the solution of the question under discussion.

A MANUAL OF TELEGRAPHY

A Manual of Telegraphy. By W. Williams, Superintendent of Indian Government Telegraphs, &c. (London: Longmans, 1885.)

A MANUAL compiled to order for the use of the *employés* of the Department—very well written, very well printed, very useful to the Department, and very interesting to the technical reader. It embraces a general description of the apparatus used in India, the faults they experience, and the remedies they apply; a full account of the elaborate system of testing reared under the care of the late Louis Schwendler, the able electrician of the Department; and a clear account of the electrical phenomena which interfere with telegraph working and require watching and removal.

It is supplemented by an excellent *résumé* of the laws which determine the strength of electric currents under various circumstances, and a series of formulæ and mathematical solutions of various problems that occur in practice. It is in reality a primer to an admirable work on "Testing," written by Schwendler and edited by another very able electrician who died in India—R. S. Brough.

It is remarkable how India, practically isolated telegraphically from the rest of the world, originated and maintains a system *sui generis*. It was sown by O'Shaughnessy, it was nursed by Robinson, it is maintained by Cappel. It has had engrafted upon it much of the German element, due to the education of Schwendler in the great house of Siemens; but it remains quite distinct from the rapid system in use in England, and also from that in America—more Continental than English, and American only in its long circuits and sound reading. It has been singularly fortunate in the able officers that have served it, most of whom are highly educated gentlemen selected by competitive examination, and well trained in technical matters before assuming office. The proceedings of our societies, especially those of the Telegraph Engineers, contain frequent valuable communications from India, and this last volume fully maintains the reputation of the Department.

There are some curious errors, particularly among those rocks upon which so many young writers are wrecked, viz. *definitions*.

There is a strange, but excusable, confusion between *electrification* and *potential*, while there is an inexcusable confusion between *current* and *quantity*. Definition 1 says "*electric quantity* is the amount of electricity present in an electrified body," and definition 2 says "the unit of quantity or current is called an "Ampère, Weber, or Oerstedt." Now the unit of quantity is called a *coulomb*, and current is not quantity, but quantity per second, a very different thing, and is called an *ampere* only. It was called a weber, but this term has quite died out since the Paris Congress of 1881, and no one ever called it an oerstedt out of India. The relation between quantity and current is shown by Faraday's great law:—

$$Q = Ct$$

It is a pity that p. 5 cannot be reprinted. Definition 16 is curiously worded: "The unit by which capacity is measured is called a *farad*, or more generally for convenience a *microfarad*." A casual reader would think that the same unit is indifferently called a farad or a microfarad, whereas we learn later on that the one is one-millionth of the other.

At p. 57 we read of a very strange practice. The only cause of errors in the signalling of figures (on which, it must be remembered, the most important issues may depend) is due to a practice, unfortunately too common, known as "exaggerating signals," by which a letter is given more characters than it really possesses: for example, the letter *h*, a most common victim of this ill-treatment, is, by the addition of an extra dot, mutilated into the figure 5. We trust this strange practice is confined to India; we have never heard of it anywhere else.

The *résumé* of laws at p. 241 is very good indeed; but why denominate Ohm's and Kirchoff's laws, and not those of Ampère and Faraday?

The novel practice, in technical books, of printing notes as well as references on the margin instead of at the bottom of the page, has been adopted, and the convenience is certainly very considerable. The printing and get-up of the book are admirable. It should be added to every telegraph engineer's library.

OUR BOOK SHELF

Elements of Inorganic Chemistry. By James H. Shepard, Ypsilanti High School. (Boston: D. C. Heath and Co., 1885.)

THIS little book is evidently intended as a sort of mutual companion of the teacher and student, and is for beginners only, as the author informs us. It is, however, a mixture of elementary and somewhat advanced information on the subject, and certainly would be somewhat difficult for a beginner to be left alone with. The book is well supplied with questions for the student to attempt, and also with suggestions to the teacher as to where questions may be with advantage put. Most of the substances known as elements are mentioned, and their properties to some extent described, even including the so-called rare metals. A chart of "The Natural Classification of the Elements," according to "Mendelejeff," and an appendix on reagents is also included.

Numerical Exercises in Chemistry. By T. Hands, M.A., F.R.A.S. (London: Sampson Low and Co., 1884.)

THIS is a neat little book of easy arithmetical exercises on chemical problems which are likely to crop up in the course of laboratory work. The examples, about 650 in number, are to some extent original and partly collected from examination papers. They extend over a good deal of the physical ground more intimately connected with chemistry, and appear to be generally of a useful character. There is no attempt at theoretical instruction beyond what is absolutely necessary for setting out a question. The first four pages are given to exercises on the metric system, after which thermometers, heat, chemical equations, &c., are dealt with. The book will be very useful for students who have got a little way into the subject, but still in the position of beginners.

An Introduction to the Differential and Integral Calculus, with Examples of Application to Mechanical Problems. By W. J. Millar, C.E. (London: Blackie and Son, 1885.)

THIS is the second attempt within a very short time to give an elementary and, as far as possible, interesting exposition of the principles of the Differential and Integral Calculus. One cannot but feel sympathy with the authors of such attempts, for, sooth to say, we often find writers on the less elementary branches of mathematics anything but good teachers or editors of students' text-books.

The present little work has the peculiarity that, being written for engineering students, its illustrations are mainly such as can best be appreciated by those who have an acquaintance with applied dynamics. It is clearly written, the examples are well chosen, and it is on the whole wonderfully accurate, considering the appearance usually made by practical men when dealing with pure mathematics. On page 7 no distinction is made between the increment of x and the square of the increment of x; on page 12 there is a faulty investigation of the rule for the differentiation of a quotient; and one or two others might be specified. These do not detract much, however, from the value of the exposition as a whole, and we cordially hope that the little book may attain its object of smoothing and rendering attractive to practical engineers the rather forbidding pathway leading to the higher mathematics.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Whole Duty of a Chemist

I CANNOT complain if the address which I delivered a few weeks ago to the Institute of Chemistry, although it received an extent of encomium for which I was quite unprepared, should meet here and there with adverse, not to say unfriendly, criticism. Naturally enough, the inculcation of sturdy self reliance is displeasing to the new apostolate of sponging upon others, though it scarcely, I think, justifies a resort to the dialectic juggle of representing the defence of one side of a chemist's duty as meant to be a deliberate expression of "the whole duty of a chemist." The Chemical Society takes cognisance of chemists in one aspect of their work, the Institute of Chemistry takes cognisance of the same individuals in another aspect; and one really need not be a conjuror, though it may put some strain on the fair-mindedness of an editor, to perceive that an address intended for the one organisation would be unsuitable for the other. That distinguished man, the late Dr. James Young, F.R.S., whom you so complacently sneer at, was not a professional chemist at all, but a manufacturing chemist. He was a first-rate manufacturer, whereas Reichenbach was but a third-rate or fourth-rate investigator, if so much; and, your opinion notwithstanding, it is commonly held that the first-rateness of the one man in his own walk more than counterbalanced whatever weight attached to the higher walk of the other. I may cite for your information Sir Frederick Abel, Dr. Frankland, Prof. Dewar, and the late Dr. Stenhouse, as being eminent professional chemists. Though of high repute in forensic circles, I am not aware of their being never heard of at the learned Societies; but I am aware that, in common with other leading chemists of the country, they have had the bad taste to be contemptuous of your own contributions to chemical science. Can it really be that this circumstance has affected unconsciously the spirit of your leading article? I would suggest, moreover, for your editorial consideration, that to supplement criticism of an author's performance with flippant insinuations as to his personal conduct and career, is hardly in accordance with the best traditions of scientific journalism; while it constitutes undeniably bad art, as implying that the production criticised did not of itself afford adequate opportunity for attack, even, of course, with an editor's happy privilege of misrepresentation. As regards the reflections so unmistakably made on myself personally, I have little fear that the irreproachable tone of your remarks will serve to suggest the measure of their trustworthiness; and will only observe "happy are they that hear their detractions, and can put them to mending." As regards, however, your disparagement of the chemical profession at large, from which, I trust, it may not suffer beyond hope of recovery, I would venture to remind you that even that other profession, of which you are so magnanimous a member, has had its calumniators; and the words of a well-known satirist of the last century are considered by some to be as applicable now as ever, that "Of all the cants which are canted in this canting world, the cant of criticism is the most tormenting." Sterne was, happily, unacquainted with the cant of scientific mendicancy, or he might have added that that also was a very fine cant in its way.

WILLIAM ODLING

Oxford, December 1.

[We print the above without comment except on the two following points. Dr. Odling has entirely misunderstood the allusion to the late Dr. Young: no sneer was intended, as will be obvious on a perusal of the whole paragraph. He has also taken as personal to himself remarks made on types not individuals.—ED.]

A Stray Balloon

THE *Times* published on September 29 a short extract from the *Bermuda Royal Gazette*, communicated by me, describing the appearance of a balloon, passing over Bermuda on August 27, and which I suggested might be one of those which ascended this year in England or France, and had not been subsequently heard of. This was followed by a letter from Mr. Charles Harding, F.R.Met.Soc., commenting on the "extreme improbability" of a balloon crossing the Atlantic, and even adding that "a little practical experience in ballooning suggests it to be thoroughly impossible."

As the columns of the *Times* are hardly suitable for the discussion, may I ask that you will allow me to make public through NATURE the further information I have received on the subject.

First, the *impossibility* is, I think, disposed of by the fact that one of the balloons sent up from Paris during the siege did actually travel rather more than half the distance, having descended in Iceland, where it was found long after. We know not how long either balloon was on its course, but it would be bold to assert that if one balloon can float four or five days another cannot float ten days. We know nothing of the exceptional conditions which prolonged the buoyancy: an unusually good varnish, peculiar folding of the silk in its collapse, a film of ice, may all be supposed capable of checking the escape of the gas. However, we have first to verify the fact. On the appearance of Mr. Harding's letter, I wrote to the Hon. W. H. Gosling, of Bermuda, a gentleman well known for his interest in matters of scientific inquiry, and begged him to investigate the story. His reply is before me, dated November 4:—

"On Saturday, October 31, I visited the spot where the balloon was alleged to have been seen. I am convinced of the fact. The place is a high hill east of the lighthouse. The two women were accidentally out in a field near where they live. Mrs. Bassett saw the object in the sky, high up, many times higher than the light. It seemed to her under the clouds. She knew nothing of balloons, and thought a whirlwind had raised some nets from the sea, as it appeared to her an object from which nets were suspended. She fancied she saw the corks of the net hanging at the bottom." (Mr. Gosling here remarks, "No doubt the basket, or the remains of it, of the former account, with chains, were the suggestion of her husband, who did not see it.") "She called her neighbour, and they both watched its course out over the sea, south, until it disappeared from view, which would not take long, as a brisk north wind was blowing. No one else seems to have seen it, nor would these, had not one of them accidentally looked up.

"I cannot hear of any balloon having been sent up in America, but on September 17, three weeks later, a balloon impaled itself on a church steeple in Chicago, U.S. The basket contained some torn clothing, and a branch of oak, as if it had come in contact with trees. The wind here on the three succeeding days was east, south-east, south. I suppose you know of the report of the missing balloon from Paris, in July, seen afterwards in the Bay of Biscay, going west."

So far Mr. Gosling, who incloses an intelligent letter from Mr. Robert T. Bassett, husband of the first witness, giving some compass bearings.

The *Monthly Weather Review* of the United States for September, which has not yet reached England, may perhaps throw light on the probability of an object seen floating in the air over Bermuda on August 27, whether arrived from Europe or not, being transported to Chicago by September 17. The coincidence is remarkable, but I know nothing of this incident beyond Mr. Gosling's mention of it. High winds with heavy rains prevailed in the South Atlantic and East Gulf States of the American Union on August 31, and the centre of a cyclone travelling in a north-easterly direction was then off the coast of South Carolina. A balloon drifting south from Bermuda on August 27 would be caught in the south-east quadrant of such a cyclone; and if it kept afloat long enough would, in a few days, be landed in a north-westerly and then in a northerly direction. The conditions of the question oblige me to assume that it is not a physical impossibility for a balloon, with very little weight attached, to drift about for weeks; but the singularity of the occurrence calls for every investigation, and should you admit this long communication, I hope that further evidence may be procurable from Chicago. J. H. LEFROY

Par Station, Cornwall, November 23

"Evolution without Natural Selection"

BELIEVING as I do that the words of a reviewer should be final, it is with no small amount of hesitation that I pen the following few remarks on the review of my little work entitled "Evolution without Natural Selection," which appeared in NATURE of November 12 (p. 26). The curious way in which my book has been misunderstood, and my consequent endeavour to put matters in a clear and impartial light, must be my apology for taking up your valuable space. In the first place, Mr. Romanes finds fault with the title of my book; but why, it is hard to conjecture. I venture to assert that nine-tenths of the matter it contains attempt to illustrate the operation of evolution without any natural selective process, as any impartial reader must admit; consequently, I absolutely deny that I only reserved a few odds and ends of small detail which I ascribed to other agencies. I might also state that I had a reason, and I think a very good one, in confining my remarks exclusively to birds. Had I elected to cover a wider area, I could have shown that these "odds and ends," as Mr. Romanes somewhat contemptuously calls them, do not by any means exclusively apply to birds, but to species in every other department of natural history. Mr. Romanes goes on to say that "It is the very essence of the Darwinian hypothesis that it only seeks to explain the apparently purposive variations, or variations of an adaptive kind; and, therefore, if any variations are taken to be non-adaptive, *ex hypothesi* they cannot have been due to natural selection." Precisely. And it was the immense amount of what I may call non-purposive variation which forms the line of demarcation between such vast numbers of species that I have attempted to explain by other agencies when natural selection utterly fails to do so. I most emphatically deny that I ever said, or even inferred, that these variations are "for the most part rare," as Mr. Romanes leads the reader of his review to suppose. All naturalists who are in the habit of working through large series of specimens are well aware of the immense number of species whose claim to rank as such is based upon their slight variation from a dominant type. It took me five years' hard work amongst tens of thousands of specimens to arrive at the conclusions expressed in my little book; and, in my opinion, no naturalist is qualified to write on these subjects without serving such an apprenticeship. That is why, as a specialist, I confined myself to birds alone for my examples. In the face of the array of important facts which I endeavoured to chronicle, it seems strange for a naturalist of such standing as Mr. Romanes to state that these facts "may be freely presented to the anti-Darwinians." Why "anti-Darwinians," Mr. Romanes? No one but an evolutionist (and most evolutionists are surely Darwinians) would attach any importance to these "trivial variations," and consequent intergradation of specific forms. Mr. Romanes is careful to point out how Darwin himself admits that if these trivial specific characters are "really of no considerable importance in the struggle for life, they could not be modified or formed through natural selection." Now probably it is no exaggeration to say that at least one-third of the known recognised species absolutely rest on these "trivial specific characters." If they have not been evolved by natural selection, I maintain that other and as equally potent agents as natural selection have been at work. The object of my little book was to try and explain them.

A word as to the *cause* of variation. No one who understands anything at all about the theory of natural selection ever supposes that it is an original cause of variation. Mr. Romanes cannot have read my essay very closely, for had he done so he would have seen that I drew the reader's attention to this fact (*conf.* p. 49). The *cause* of variation is quite another question, and one which after all did not materially concern my treatment of the subject. Nevertheless, I alluded to the use and disuse of organs as a direct cause of variation. I would also wish to point out that Mr. Romanes is entirely in error in saying that I "everywhere speak of isolation as the *cause* of minute specific characters." All I endeavoured to show was that isolation can preserve a non-beneficial variation when it has arisen, just as much and effectually as natural selection can preserve a beneficial variation.

Did space permit, I would like to say a few words on climatic variation, and the probable times at which natural selection is most active in the evolution of species; on both which subjects Mr. Romanes unconsciously misrepresents me. My reviewer has nothing whatever to say on my treatment of sexual selection; the use and disuse of organs, inter-crossing, the local distribution of specialised forms, polar centres as points of dispersal, &c.

Mr. Romanes seems to think that my little book was written in an anti-Darwinian spirit. Nothing of the sort. On my last page but one I said, "Let it be clearly understood that not one single syllable in the foregoing pages has been written antagonistic to Darwin's theory of Natural Selection. All I have done has been to attempt to explain certain phenomena which the Darwinian hypothesis can never do, and which its supporters ought never to have attempted to make it explain." If I have not made my meaning plain, and thus left myself open to misunderstanding, it will be a source of great regret. Science and simplicity should be synonymous. In the French edition, shortly to be published, which is now being translated by Dr. Varigny, of Paris, I hope to make a few corrections and additions, which I trust may possibly render me less liable to be misrepresented in future. CHARLES DIXON

London, November 21

I FREELY admit that the impression left upon my mind after reading Mr. Dixon's essay was the same as that which was first conveyed by its title—viz. that the author supposed his work to be, if not "antagonistic to Darwin's theory of Natural Selection," at all events, as I expressed it, "an important emendation of Darwinism." My object, therefore, while reviewing the essay was to show that this is a character which does not belong to it. If I have misunderstood the meaning of its author on this fundamental point, I should have been glad to have received a more express statement of the fact than appears in the above letter; for I might then have felt that Mr. Dixon's views with reference to the value of his work are in full accordance with my own. As stated in the review, I consider his facts most interesting as examples of trivial specific characters—or slight variations of a fixed kind—due to variation presumably unaided by selection; and when I said that such facts "may be freely presented to the anti-Darwinians," I meant that they might be so presented to any one who supposed them anti-Darwinian. It appeared to me that Mr. Dixon himself regarded them in this light (though not as anti-evolutionary), at all events to the extent of imagining that they had not been sufficiently recognised by Darwinians. But, as I have said, if such is not his meaning, I am very glad to find myself in agreement with him upon this point.

I spoke of these trivial specific characters as "odds and ends," and as of "comparatively rare occurrence," because, although both numerous in themselves and of importance for the purposes of detailed classification, they are insignificant when compared with the whole organising work of natural selection. And if, as Mr. Dixon now repeats, it was the object of his little book "to try and explain the agents" (*i.e.* the *causes*) producing these non-purposive specific characters, I can only repeat that in this respect his book has failed in its object. Lastly, my only reason for not mentioning Mr. Dixon's views on natural selection, &c., was that I found nothing in these views particularly deserving of mention. GEORGE J. ROMANES

On Radiation of Heat from the Same Surface at Different Temperatures

WITH respect to my recent communication to you on the subject of radiation of heat at different temperatures (p. 85), I wish to remark that the temperature given as the temperature of the surroundings must be taken as only approximate. A remark to this effect was in fact included in the first draft of my note to you, and was inadvertently omitted in the final copy.

If the glass envelope surrounding the wire were perfectly diathermanous, and likewise the intervening air, then the temperature of the surroundings would be simply that of the walls of the room. As it was there is a great difficulty in saying precisely what is to be taken as the temperature of the surroundings. The glass envelope becomes heated to some extent, and will return a certain amount of radiation to the wire. When the vacuum is nearly complete, however, the heating of the glass is slight, and is very small in comparison with the heating when the vacuum is only partial.

The reason I have not used a metallic envelope blackened inside and cooled outside, is that it is very difficult to attach such an envelope in a satisfactory way to the Sprengel pump. I am, however, hopeful of being able to overcome this difficulty.

November 28 J. T. BOTTOMLEY

THE NOVEMBER METEORS

THE watch which was kept on November 27 in the hopes of seeing a shower of meteors from the stream connected with Biela's comet was very amply rewarded. At the Royal Observatory, Greenwich, the weather was somewhat unfavourable, the sky being partly clear only at intervals, yet, when the meteors were first seen, between 6h. and 7h. p.m., they were appearing at the rate of from 30 to 40 per minute. The average brilliancy of the meteors was remarkable. The radiant-point as determined at the Greenwich Observatory from a number of paths was estimated to be about R.A. 20°, Decl. 49° N.

We have received the following communications with reference to the meteor showers:—

THE great display of Andromedes, or meteors of Biela's comet, which occurred on the evening of November 27 last, and which fortunately has been widely observed, adds another corroborative link to the theory, already demonstrated by facts, connecting comets and meteors. Not only does this stream exhibit a perfect orbital resemblance to that of the comet with which it has been associated, but it recurs only at the special times when, according to computation, the comet is in the vicinity of that region of its orbit encountered by the earth on November 27.

Many meteors appeared on the evening of November 26 this year, the hourly rate, as estimated at Bristol, being considerably over 100, and they nearly all belonged to the shower from Biela's comet. But the display on that night was not of very exceptional richness, though it gave distinct intimation of what was to follow. The meteors of November 26 were simply the *avant couriers* of the advancing host, for, as soon as twilight deepened on the following evening, it was seen at once that the shower had greatly intensified. Meteors were falling so thickly as the night advanced that it became almost impossible to enumerate them. Frequently they came in simultaneous groups of five, seven, or ten, all radiating from the immediate region of the star γ Andromedæ, and appeared in every quarter of the firmament with that uniform slowness of movement which is a peculiar feature of the shower.

The prediction that such a display would occur has thus been completely verified, and the character of its leading features has been precisely conformable to anticipation. For not only has a meteor-shower occurred at the appointed time, but it has coincided in all its salient attributes with what has been expected. The radiant-point near γ Andromedæ has been accurately marked, as on November 27, 1872, and the meteors have presented the same visible traits of appearance.

As to the strength of the display, it has been variously described, but there can be no doubt, from the observations, that it will rank in importance with any similar phenomenon recorded in modern times. At stations where the clearness of the atmosphere permitted its full grandeur to be recognised, it would seem that about one meteor per second was counted, and this means a rate of 3600 per hour.

These facts warrant us in the assumption that the earth has recently encountered a very dense region of the meteor-stream. Notwithstanding that these meteors have to overtake the earth in her orbit, and that they therefore travel with the minimum velocity (about eleven miles per second) possible in the case of such bodies, they have returned in surprising abundance. A far more attenuated system, encountering the earth under similar conditions to the Leonids of November 13, which directly meet the earth in her path, must have originated a more numerous display, because a far greater range of such a stream would be traversed in the same interval. Here the velocities of the earth and meteors would be combined by the favourable circumstances of the *rencontre*, and the earth would really penetrate the stream at the rate of some forty-four miles per second. But in the instance of the meteors from Biela's comet, they are travelling in the same general direction as ourselves, and it is only their greater native velocities which enable them to catch up the earth, and become visible in the form under which we have just observed them.

When all the accounts of this remarkable display become available for reduction, it will be important to compare them with those of its predecessor in November, 1872. Though the present shower has been an obvious repetition of the one just referred to, it may exhibit some differences which it will be essential to investigate. In one respect certainly there would appear to be a want of accordance. We refer to the relative durations of the two displays. In 1872, on November 26 and 28, that is, on the nights preceding and following the great shower, very little sign of it appears to have been observed. It was immediately confined to the night of November 27. In NATURE, vol. vii. p. 104, Prof. Herschel writes:—

"On the evening of the 28th [November, 1872], Mr. Greg watched for shooting-stars, and for any remnants of the star-shower of the previous evening which might be visible, but although the sky was quite clear, he failed to see any meteors. A strict watch for outlying meteors of the shower was also kept by two observers at Hawkhurst, in Kent, on the evening of the 28th, where the sky was quite cloudless between 9h. and 11h. 15m. p.m., but without success, only four shooting-stars of ordinary character being visible."

Prof. Herschel also quotes some observations proving that on November 26 of that year, meteors were singularly rare, and justly concludes from this that the display was confined to an interval of forty-four hours. Now the recent phenomenon was already a conspicuous shower on the 26th, when it was observed at Bristol at about 8.30 p.m., and on the 28th, in a four-hours watch before 11.30, 55 Andromedes were counted in a cloudless sky. We here have a period of fifty-one hours for its observed duration, but there is not the slightest doubt from the activity it exhibited at the opening and termination of the observations this year, that the shower must have been probably visible both on November 24 and 25, and also on the 29th. At Bristol the sky was overcast on these dates, so that the progress of the display during its complete rise and decadence could not be observed. It is certain, however, that it extended over several nights, and that its increase was more gradual, as in the case of the August Perseids, than its decline.

The outlying members of the shower observed at Bristol in the very clear sky of November 28 this year were extremely faint, the majority being of the 5th and 6th magnitude. It is therefore suggested that on the environs of the denser part of the stream, the meteors are of very diminutive size, and this may possibly have enabled them to elude detection at places where the atmosphere was not very clear. W. F. DENNING

AN extraordinarily bright display of Cassiopeiad shooting-stars occurred this evening, commencing, I am told, as soon as darkness set in, at about five o'clock. The sky was then cloudless here, but owing to street-lights I missed observing them between five and seven, and until informed of their appearance a little after half-past seven o'clock. Reaching an open space, and looking up at Cassiopeia, just overhead, I then counted about twenty meteors, all with short courses near that constellation, in the four minutes onwards from 7.40. Such a thick haze overspread the sky except just round the zenith, that only the bright stars of Cassiopeia and two in the Square of Pegasus (β Pegasi and α Andromedæ) were visible there; but several first and second magnitude meteors of the display which proceeded at the same rate until 7.50, left streaks on their short courses visible for two or three seconds through the haze, and these being sometimes actually in sight in groups together, made the direction of radiation very easy to determine. The thickening haze, however, hid the stars so completely at the latter hour, and afterwards, that further observations of the shower for the night have proved fruitless.

To my surprise, this active meteor-shower was diverging, not from the usual Biela radiant-point near γ Andromedæ, but the short meteor-tracks all streamed away from Cassiopeia! This was conspicuous in the meteors near Cassiopeia which travelled thence, as most of those visible did, westwards and southwards towards the Square of Pegasus across Honores Frederici, and eastwards and northwards across Camelopardus and Custos Messium. Although no faint stars in sight allowed their courses there to be regularly mapped, yet, from such a short collection of very good accordances for fixing it very nearly, I would place the radiant-point (by rough eye-estimation only) very near α, or between ζ, η, and θ Cassiopeia, which is about 15° from the Biela radiant-point near τ Andromedæ.

In his "Periodische Sternschnuppen," published at Aix-la-Chapelle in 1849, Heis described a radiant-point of several meteors seen there by him on the nights of December 8 and 10, 1847, between γ and τ Andromedæ, as a prominent one on those nights; and on the evening of November 30, 1867, Zezioli, at Bergamo, mapped a number of meteor-tracks, from which Prof. Schiaparelli obtained a well-marked radiant-point position closely agreeing, like Heis's, with the subsequent exact determination of the place of the "Andromede" star-shower's radiant-point made by numerous observers of the shower's great return on November 27, 1872.

Besides the radiant "A" in Andromeda, seen on the nights of December 8 and 10, 1847, Heis also described, in the same work, another, "C," close to α Cassiopeiæ, as conspicuous on the nights of November 12 and 13, in the years from 1839 to 1847; and he notices that Danse (*Comptes rendus*, vol. v. p. 759), on November 15, 1837, observed a shower of seventeen shooting-stars in a minute and a half diverging from the constellation Cassiopeia. In connection with the December epoch it is also noted that of a large number of meteor-tracks observed by Herrick at Newhaven, U.S., on December 7 and 8, 1838, about three-quarters diverged from the principal stars of Cassiopeia, and that Flaugergues, at Toulon, in France, made a similar observation on December 6 of the same year, 42 meteors, about 9 o'clock, falling vertically from the zenith, and 31 of them on nearly parallel courses from about Cassiopeia's place in it (as the account implies) between the Milky Way and the Square of Pegasus.

Although the connection of this "Cassiopeiad" stream with Biela's comet would seem, from the position of its radiant-point, to be somewhat doubtful, yet the occurrence now, as it appears, of a shower with nearly the same radiant point on the night of the famous Biela star-shower's date in 1872, makes the probability much greater than before that the "Cassiopeiads" of December 6 to 10 and the "Andromedes" of Heis, belonging to the same date and to November 27 to 30, may not be unassociated star-showers, but that both may possibly have had their origin in some bygone disruptions of Biela's comet! The position of this star-shower's radiant-point will, it is to be hoped, have been determined accurately by more fortunate observers than myself of its very striking apparition, so as, if it befits them, to corroborate these slight observations generally, and to fix the shower's centre of divergence with the astronomical position which is most desirable from these suggestive indications.

Four Leonids, varying from first to third magnitude stars in brightness, and leaving no streaks, were seen here between 2.10 and 2.50 a.m. on the 15th inst., together with two small sporadic meteors, in a clear moonless sky. They indicated plainly, by the accordant radiation outwards on a map of their long swift courses, from a moderately wide area in Leo's Sickle, a slender recurrence of that great star-shower this year. Its maximum now appears to present itself at least as distinctly on the morning of the 15th, as on that of the 14th of November, as the nodal line of the meteor-stream advances. Its short-lived displays, it may be gathered from this regular progression, need scarcely now be looked for any longer, on that account, on either of the historically famous dates of the 12th and 13th of November, of its once pre-eminently grand and imposing exhibitions, while a centenary view of one of those is not actually now a very distant event to look forward to on a coming 15th of November morning in the year 1899.

A. S. HERSCHEL

Newcastle-on-Tyne, November 27

P.S.—*November* 28.—On looking at the stars in a clear sky to-night, I find that those described above as having been just visible near Cassiopeia were not chief stars of the Square of Pegasus, as supposed, but bright stars in Cygnus and Cepheus! Instead of crossing Honores, therefore, the chief meteor-flights of the stream observed were shooting from the true Biela radiant-point near τ Andromedæ, past Cassiopeia into Cepheus. Other stragglers there certainly were, whose general radiation from Cassiopeia could not be thus accounted for. Just similar variations of direction, however, were common among a rather large proportion of the "Andromedes" in the great shower of November 27, 1872, which had rather an average than a very sharply marked radiant-point in Andromeda. There appears no reason to doubt, therefore, that on this occasion also the shower proceeded from the same prevailing centre of divergence.

From many observers' descriptions of it here, the present shower would seem to have been hardly, if at all, inferior in any respect—of duration, of brightness and multitude of its meteors, or of persistency in the light-streaks left upon their tracks—to the great and well-remembered display of the Biela's comet meteor-shower in November, 1872.

AS you may be desirous to make known any observations respecting the meteor-shower of the 27th inst., I beg to furnish you with those noticed by myself.

At sunset the sky was overcast, but happily at 6.30 p.m. the clouds dispersed, when the phenomenon was seen here in full splendour; the heavens were alive with the meteors making their rapid appearance and extinction.

My attention was attracted chiefly to the constellations of Cassiopeia, Andromeda, and towards Perseus, from whence the most brilliant portion of the shower was in operation, and from that locality the most conspicuous meteors shot forth. Selecting the most remarkable out of the numerous luminous trains for their length of traverse, and conceiving the line of direction to be thrown backwards, the convergence of these trains concentrated towards a point in Andromeda, in accordance with the position of the radiant-point as predicted in the Dun Echt Observatory Circular.

The paths taken by the above meteors were, in many cases, directed towards the southern horizon, and several towards the Pleiades in the east, from the radiant-point; others flitted away to every point of the compass, exhibiting longer or shorter trains during their ephemeral existence.

The general illuminating effect produced by the shower was appreciable, but it was not very powerful; and with regard to the colours which were exhibited in the luminous trains, my views combined with the opinions derived from other observers coincide—that the colour aspect of these transient illuminants varied apparently between golden and very pale-green tints.

But with reference to the zenith and its surrounding region, it was noticeable there that the conditions of the meteors had other characteristics, inasmuch as they were almost devoid of path or connection with any radiant-point, they were remarkably numerous, a great proportion of them exhibited no more than feeble flashes or scintillations of white light, the display was maintained with great rapidity and continuously.

It was also noticed that an erratic meteor was seen occasionally taking an independent course of considerable length, about 45° of arc, sometimes at low elevation, making an acute angle with the horizon.

About 7.15 p.m. clouds obscured the sky for the night, so I did not see either the beginning or the termination of this interesting phenomenon.

Comparing the great display of meteors which I observed in November, 1866, it was in all respects more magnificent than this recent shower. I could not on this occasion define any head or nucleus to any of the luminous trains, but this feature was remarkable in the large meteors of 1866.

As a single observer, it was impracticable for me to attempt any enumeration of the enormous number of meteors, and to observe the prominent features of the phenomenon at the same time. At midnight it was blowing a strong gale from the south-west; thick weather, with a mild temperature of 53°.

ERASMUS OMMANNEY

Yarmouth, Isle of Wight, November 29

THINKING, from the character of the weather on the night of the 27th, that opportunities of seeing the late splendid display of meteors may have been extremely local, I have taken the liberty of forwarding my notes of them as I saw them here from between a little before 6 p.m. until 7.35 p.m. How long the shower had been going on before (attracted by the cries of some passing boys) I looked out, I cannot say, but just before six when I did so, the sky was covered in many places with a thin haze, through which the larger stars and planets were looking greasy, as sailors say, while in nearly every direction meteors were gliding and bursting from a point a little to the eastward of the zenith toward the horizon; the meteors varying in brightness from that of the planet Venus to the faintest streaks of light. The larger ones were very like pale inverted rockets, having trains of many degrees in length, and often prismatic in colour; that is, near the head the light of the train was bluish, blending from green to yellow, followed by rose or crimson sparks. In many cases this train was visible for quite thirty seconds after the star was burnt out, first as a bar of warmish dusky light, and often becoming curved, as though by wind, as it faded away.

The silence of the display was almost oppressive, as one expected each moment to hear the bang of fireworks. During most of the time masses of luminous-looking vapour floated slowly across the sky. Some of the meteors seemed to burst end on, right over head, and though, being foreshortened, these left no train, yet they were among the brightest. I noted a considerable variation in the speed of the meteors, and am inclined to think that those which appeared farthest off moved slowest. It was next to impossible to say in which direction the star rain was thickest, for just as one was trying to make up one's mind upon this point, a troop of stars from an unexpected part of the sky would appear. Other observers may be able to speak more positively than I can upon this subject; but my impression, as well as that of those who saw them with me, was that they streamed down in groups of two, three, and four toward almost every point of the compass. About 7.20 p.m. the number seemed to become rather less, and at 7.35 this was markedly the case, though they were quite frequent enough then to have attracted attention any other night. Shortly after 7.35 the sky here became overcast by a storm-cloud, and it has remained so ever since, blowing a hard gale at S.S.W.

ROBERT LESLIE

Moira Place, Southampton, November 28

A BRILLIANT display of the Andromedes was seen here on the night of November 27 from about 6 p.m. to 9 p.m., after which time the sky was clouded over. During a walk of ten minutes (from 6.20 to 6.30), facing the north-west, I counted 150 meteors within that half of the visible heavens; and as they appeared to be nearly if not quite as numerous in the other half their total number would not be less than 1500 per hour. The radiant point was almost directly overhead. The meteors varied greatly in size, many being very small and faint. The larger ones left bright trails of a white or bluish colour. I observed one only in an opposite direction, and none with curved or zigzag paths. The shower was less grand than that of the Leonids in 1866, in which there was a larger proportion of brilliant meteors, many of them coming in flights of three to six at once, all near together; but with that exception the display of the Andromedes this year was the finest piece of celestial pyrotechny I have ever had the good fortune to witness. We seemed to stand under an encircling canopy of dropping lights.

Birstal Hill, Leicester, Nov. 28 F. T. MOTT

AN extraordinary meteoric display was visible here last night. I first observed it at 6.40 p.m., and was watching it at intervals for more than an hour later, when the sky became overclouded. Altogether the number of shooting-stars was immense. Unlike the correspondent of the *Daily News*, who observed a similar phenomenon at Naples the same night, I was unable to count the number per minute. Appearing suddenly, and often many at a time, in all parts of the heavens, from the zenith to the horizon, they quickly disappeared from view, the distance travelled not being more than a few degrees in any case. Some were much more luminous than others, and all in their passage through the air were followed by the usual trail of light. E. F. BATES

Leicester, November 28

THOUGH densely cloudy during the afternoon of the 27th, the sky became clear here about 6.30 p.m., when great numbers of meteors were to be seen, falling at the rate of fully 60 per minute, many being of great brilliancy. During the evening their number gradually decreased, till towards 10 o'clock very few were visible. The sky then again became overcast. PERCY T. INGRAM

Belvoir Gardens, Grantham, November 29

THE star-shower predicted by several astronomers was well seen here on Friday evening last. When first observed, at 5.30, the rate of fall was 25 per minute; the numbers, however, increased rapidly during the next half-hour, till, at 6 o'clock, more than 100 meteors were counted in a minute.

At 6.20 a marked decrease in the intensity of the shower was noted; but at 6.38 the numbers once more increased, till a rate of 70 per minute was attained; after this, however, they gradually diminished as the hours went on. It is right to mention that the numbers given above are those of the meteors seen by an observer looking towards the east; they do not represent the total number that fell at these two periods.

The radiant-point, as indicated by the position of several meteors which suddenly flashed out without sensibly changing their position, was close to γ Andromeda, or, more exactly, R.A. 21°, N.P.D. 46°.

Most of the meteors were mere "shooting-stars"; a large number, however, had brilliant phosphorescent trains, which continued to glow for several seconds after the meteors themselves had vanished. Occasionally one of the trains would break up into fragments, and in one instance a curious spiral form was assumed.

A special feature of the shower was its varying intensity, and that more particularly between 6 and 7 o'clock.

JAMES SMIETON

Broughty Ferry, Dundee, November 30

OUR Paris Correspondent writes:—The shower of falling stars has been observed at a number of French stations—Toulouse, Central France, Tunis, and Algiers. The point of emanation was, in the case of some of them, between Andromeda and Cassiopeia. In Paris it was not observed, owing to the foggy state of the atmosphere, and no balloon observation having been tried.

The following letters on the meteors appeared in the *Times* of Saturday:—

Mr. T. G. Dyson, of 1, Rothesay Villas, Windsor, wrote on Friday night:—"I was fortunate in witnessing this evening from 6.15 to 6.40 a most magnificent shower of stars, which might be compared to a flight of swallows, with a lull of a few seconds between each flight. Although the sky was anything but clear—only stars of the larger magnitude being visible—the meteors were brilliant, and in many instances left a distinct trail behind them. The direction was principally from east to west, varying to north-west."

The Leicester Correspondent of the *Times* telegraphed last night:—"A remarkable display of meteors was witnessed in Leicestershire to-night from dusk until a late hour. The display was most brilliant towards the western horizon, the meteors falling in perpetual showers, with brilliant trails, like a very fine display of fireworks."

A Reuter telegram from Athens, dated November 27, says:—A brilliant shower of meteors was observed here to-night."

A Newcastle-on-Tyne correspondent telegraphs:—"There was a splendid meteoric display here. I saw about 500 an hour. Radiating point Cassiopeia."

Prof. Pritchard, of the University Observatory at Oxford, telegraphs that he counted 251 meteors between 6.34 and 6.39 p.m., and 305 between 7.14 and 7.19.

IN case no one else may have reported the complete fulfilment of the prediction suggested by Lord Crawford's Dun Echt Circular allow me a few lines to do so.

I did not begin to observe systematically until nearly 8 p.m. (7h. 58m.), when I found that, confining my attention to one-third of the sky (south-south-east to west-north-west), and computing therefrom, meteors were falling at the rate of 33 a minute. Shortly after this they became more numerous, and from 8h. 5m. to 8h. 10m. they were falling at the rate of 56 a minute (nearly one a second), or more than 3000 an hour. From 8h. 30m. to 9h. 30m. the view was much hindered by cloud, but it was evident that the number was decreasing. From 9h. 30m. to 10h. the average fell to about 12 a minute, or scarcely a fifth of what it was at 8h. 5m.; and shortly after 10 p.m. the sky became entirely overcast.

I well remember the glorious shower in 1866. On that occasion the meteors were both larger and more numerous than they have been this evening, but occasionally they were very frequent—for example, at 7h. 59m. five were visible in less than two seconds (the precise period was one second and six-tenths).

G. J. SYMONS

62, Camden Square, N.W., November 27

In Paris, according to the *Times* Correspondent, the sky was overclouded all Friday night, but the meteor-shower was seen to advantage in the South of France, in Belgium, Germany, Spain, and Italy, as also in Tunis, where the natives were much startled. At Châtelhérault the meteors were well seen. At Cologne, Dr. Klein counted 636 between 6 and 7 o'clock, though the sky was at times overclouded. Most of them moved very slowly and left a trail of light, which quickly disappeared. Four were large and brilliant enough to be styled fire-balls. From 7.30 to 8 he counted 309, from 8.30 to 9 there were 375, and from 9 to 9.30 there were 208. The sky then became cloudy. Not one can have reached the ground, for they must have burned out and dispersed in the upper atmosphere. At Munich the sky was perfectly clear, and the display was very striking.

THE LATE SIR WILLIAM SIEMENS

ON Thursday last the relations and friends of the late Sir William Siemens assembled in the Jerusalem Chamber of Westminster Abbey for the purpose of doing honour to his memory by the unveiling of a memorial window, which has been contributed by members of the five engineering Societies with which Sir W. Siemens was associated in the Abbey. The day was chosen as being the second anniversary of the funeral service which was held in the Abbey previously to the interment of the great *savant* at Kensal Green Cemetery.

Among those present were Mr. Arnold Siemens, Miss Gordon, Dr. Werner Siemens, and Mr. Alexander Siemens. Of the Civil Engineers Sir Frederick J. Bramwell, F.R.S., President, Sir Charles H. Gregory, K.C.M.G., Mr. Bateman, F.R.S., Mr. Barlow, F.R.S., Sir J. W. Bazalgette, C.B., Mr. Preece, F.R.S., Sir R. Rawlinson, C.B., and others, besides representatives of other Societies, among them Admiral Sir R. Spencer Robinson, K.C.B., Dr. Percy, F.R.S., Sir Bernhard Samuelson, Sir Henry Bessemer, F.R.S., Prof. W. G. Adams, Sir F. A. Abel, C.B., Prof. D. E. Hughes, F.R.S., Prof. Ayrton, F.R.S., and Dr. Hopkinson, F.R.S.

The Dean opened the proceedings by a brief address. "It is not for me," he said, "to dwell for a moment on the signal services to the cause, not only of science, but still more the application of science to the well-being of mankind, that will be always associated with the name of Sir W. Siemens. But I may add my own personal testimony to the impression which the character of your friend and leader, for such in a wide range of subjects I may surely call him, made on all who came into contact with him. He was, as you know, and as I know, not only admired and honoured, he was beloved and deplored. May the window which we shall now uncover do its proper work. . . . And may it remind us and far-off generations of the achievements and character of him whose memory will henceforth be here linked with that of his illustrious brethren, whose names the floor on which we shall soon stand, and the walls beneath which we shall pass, proclaim and preserve—the Newton, the Herschel, and the Darwin, the Stephenson, the Locke, and the Brunel, the Barry, to which add the Gilbert Scott, and Street—who sleep, or are honoured hard by."

Sir F. Bramwell, who spoke as the President of the Civil Engineers, the senior of the Societies represented, then made some remarks on Sir W. Siemens's contributions to applied and pure science.

The window, which has been designed and executed by Messrs. Clayton and Bell under the direction of Mr. J. L. Pearson, is intended to illustrate the maxim "Laborare est orare." It consists of two lights with a sixfoil in its traceried head. Each of these lights is composed of three panels in vertical order. In the left-hand light appear ironsmiths, chemists, and agriculturists; in the other groups in corresponding positions show astronomers, artists, and the professor with his scholars. Between these groups are in all cases angels bearing labels inscribed with the words giving the key-note of the conception—namely, "Laborare est orare." In the sixfoil at the head of the window is a representation of the sun as the source of light, surrounded by the words, "Dixit autem Deus fiant luminaria in firmamento cœli," and by the various heavenly bodies from which light emanates or is reflected. At the base is the following inscription:—"In memory of Charles William Siemens, Knt., D.C.L., LL.D., F.R.S., Civil Engineer. Born 4 April, 1823; died 19 November, 1883. Erected as a tribute of respect by his brother Engineers."

NOTES

It is gratifying to be able to announce that a pension of 300*l.* a year has been conferred upon Prof. Huxley from the Civil List Fund. We are also much pleased to notice the admirable articles in the *Times* and other papers on the retirement of Sir Joseph Hooker and Prof. Huxley, indicating, as they certainly do, the general growth of scientific interest.

We regret to learn of the death, in his 72nd year, of Prof. Thomas Andrews, F.R.S., the eminent chemist. We hope to be able to refer to his work in detail in our next number.

Botanists all the world over, we are sure, will be glad to learn that Mr. W. T. Thiselton Dyer, C.M.G., F.R.S., has been nominated to succeed Sir Joseph Hooker in the Directorship of Kew Gardens.

Our Paris Correspondent informs us of the death of M. Bouley, President of the Paris Academy of Sciences, who was to have held office until the first meeting of 1886. M. Bouley, who was born in Paris in 1814, died of heart disease, under which he had been labouring for many years. He was, during many years, Director of the Veterinary School of Alfort. He has published a large number of memoirs on physiological researches, and was a popular writer and an eloquent debater.

The reports of observations of the total eclipse of the sun of August 7, 1869, made by parties under the direction of Prof. Coffin, Superintendent of the *American Nautical Almanac*, have recently been published by the authority of the Secretary of the Navy. All lovers of astronomy will regret to know that this late publication in full of observations made sixteen years ago is due to the failing health and sickness of Prof. Coffin. This is, however, the less to be regretted since pretty full reports were made by the individual observers at the time, and the important observations secured have in this way found their place among the records of eclipse phenomena. The illustrations which accompany the volume are very beautiful.

We have received No. 15 of the professional papers of the Signal Service of the United States Army, containing a full account of Prof. Langley's researches on solar heat and its absorption by the earth's atmosphere, undertaken during, and in connection with, the Mount Whitney Expedition. Prof. Langley has already himself given an account in Nature of the important results he thus obtained. A perusal of the volume, however, shows that all who are interested in this subject will do well to refer to the present volume and the more detailed accounts they will find there touching the various parts of the research. It is a monument of industry and skill and undaunted perseverance of which Prof. Langley may well be proud.

The Christmas Lectures at the Royal Institution will be given by Prof. Dewar, on "The Story of a Meteorite" (with experimental illustrations), commencing on December 29. Courses of lectures will probably be given before Easter by Prof. R. S. Ball, Mr. R. S. Poole, Mr. C. T. Newton, Dr. A. Gamgee, Mr. W. C. Roberts-Austin, Prof. Boyd Dawkins, Prof. Tyndall, Mr. A. Geikie, Rev. C. Taylor, Mr. E. B. Poulton, and Mr. H. Grubb. The Friday Evening Meetings will begin on January 22, when a discourse will be given by Prof. Tyndall. Succeeding discourses will probably be given by Sir William Thomson, Mr. T. P. Teale, Prof. O. Reynolds, Mr. W. K. Parker, Mr. A. A. Common, Prof. A. Macalister, Mr. R. S. Poole, Mr. W. H. M. Christie, Mr. W. Anderson, Sir Henry Roscoe, and others.

The curriculum of the Paris School of Ethnology (founded by M. Broca in 1876) for the current session embraces courses of lectures on zoological, general, and prehistoric anthropology, ethnology, medical geography, and the history of civilisation. The course on linguistic anthropology does not commence until the spring. On zoological anthropology Dr. Duval will lecture on anthropogeny and comparative embryology: the blastoderm and the first phases of development. In general anthropology, Dr. Topinard will take type and race: the first part analytical—the races of Europe from prehistoric times down to our own days; the second part synthetical—the succession and transformation of races, their past and future. In ethnology, Dr. Dally will take ethnical craniology; in prehistoric anthropology, M. Mortillet takes Tertiary man; and in the history of civilisations, Dr. Lebourneau will lecture on the evolution and ethnography of morality.

We have received the price list of the publications of the Smithsonian Institution up to July last. It includes only such publications from 1847 to the present year as can be supplied, all others being out of print. The latter are very numerous, for of the first hundred publications only forty-six are now to be procured, the remaining sixty-four being out of print. The list first gives the papers according to their numbers in the publication catalogue of the Institution, then according to the authors, then according to their subjects, and finally they are arranged under heads according to their mode of publication, such as "Annual Reports," "Contributions to Knowledge," "Proceedings of Societies," &c.

Telephonic communication between Paris and Rheims was opened to the public on Tuesday. The distance is 172 kilometres, but the electric resistance to be overcome between the two points is estimated at 217 kilometres. The ordinary telegraphic wire is utilised for the purpose, but there is a special telephonic station in the Plain of St. Denis, at the Pont de Soissons. The tariff is one franc for five minutes' conversation. At the inaugural *séance*, conversations were held with sundry public functionaries at Rheims, whose voices were heard with perfect distinctness.

Prof. Du Bois-Reymond, it is known, has recently availed himself of good opportunities for studying the electric ray in the live state; and among several important facts elicited by him is that of irreciprocity of conduction in the electric organ. That is, when short currents are passed through the organ in the same direction as that of the animal's proper current, viz. from belly to back, and in the reverse direction, the conductivity in the former case is considerably greater. This irreciprocity begins to appear only when the current has acquired a certain strength; it increases with the strength, but more slowly. Both this irreciprocity and the small conductivity of the organ (which is considerably less than that of sea water) are proved to be connected with the life of the animal; the former disappears and the latter increases in the case of spontaneous death. The former depends also on the duration of the current, diminishing with a continuous current. This phenomenon of irreciprocity appears to have the effect of strengthening the animal's current and so intensifying its physiological action in external space. The author's researches on the subject have been recently laid before the Berlin Academy (*Sitzungsberichte*, Berlin Academy, 1885, p. 691).

The fresh-water mussel, it is known, closes its shell by contraction of two strong muscles—one before and one behind; but how does it open its shell? This question has recently been studied by Herr Pawlow (*Pflüger's Archiv*). The animal (*Anodonta cygnæa*) was fixed on a board by one shell, while the other free shell was connected by means of a silk thread with the short arm of a lever, the longer arm of which indicated the movements on a slowly-rotating drum. The nerves were variously irritated; but without giving details we may say that Herr Pawlow finds there are two classes of nerve-fibres connected with the muscles—the one motor, producing contractions; the other inhibitory, producing relaxation. The motor nerves for each muscle spring from the ganglion next it; the inhibitory fibres all proceed from the two front ganglions. The posterior ganglion can thus only send an impulse of movement to the posterior closing muscle, while the front ganglions, besides being thus related to the front muscle, can also produce relaxation in both muscles. When separated from the ganglions belonging to them the muscles pass but very slowly from the contracted to the relaxed state. A remarkable fact, noted by Herr Pawlow, is that by stimulation of the nerves in the muscles contraction does not always follow, but sometimes relaxation. Such phenomena are rare; they have been observed in the blood-vessels, and Herr Biedermann has noticed them in the heart of the snail.

The hatching of fish-ova has commenced at the establishment of the National Fish-Culture Association, South Kensington, several agents having been employed lately to artificially spawn fish, which in many parts are well forward. The species chiefly operated upon have been the *Salmo fario* and *S. levenensis*. The American Government have promised to forward large consignments of ova from the various species of Salmonidæ abounding in their waters, particularly the whitefish, whose eggs will be incubated in very large numbers by the Association.

The telegraph system of the Great Northern Telegraph Company has been extended to Seoul, the capital of Corea, and to its port, Jenchuan, or Chemulpo. These two places are therefore in telegraphic communication with the rest of the world.

A writer in the *North China Herald*, on ethnology in China, points out that while there have been geologists, botanists, and zoologists in China, no one has yet given himself specially to ethnology who was already distinguished in it. The province of Szechu'en is a very interesting and important region for the work of the ethnological geographer, because of the Thibetan tribes, the Lolos, and others located there. In the historical ethnology of China, De Guignes led the way in the last century in his "History of the Huns," which unfortunately were not the real Huns, for the Huns of Hungary were not, as he supposed, the powerful race known in China as the Hiung Nu. Yet he did much in elucidating the history of all the Tartar races, and his great merit was that he collected a large store of historic facts from Chinese sources, from the second century B.C., when the Chinese began to know Tartary, down to the days of the Mongol conquest. Klaproth settled the point who the Hiung Nu really were by the simple method of taking the words mentioned as theirs by Chinese authors, and finding out to what linguistic stock they belonged. Besides making this step forward, Klaproth also tabulated the facts of Chinese history relating to all Asiatic races.

What remains to be done for ethnology in the field of Chinese history is, the same writer adds, by no means a small amount of work. It is possible to trace the Indo-European races mentioned by ancient Chinese authors, and follow them in their movements westward, from Kansu to the Tsemgling mountains, and beyond, where at Bokhara and Kunduz they meet with other Indo-European stocks. In the north-west, besides these, Chinese history introduces us to several Indo-European peoples, occupying before the birth of Christ the country around the Sea of Aral, from which the Germanic races appear to have moved westward. The Chinese tell us nothing of the first emigrants, the Cimbri and Celts, but they give very considerable information about the Germanic races, the value of which has not yet been fully appreciated. Then the Huns, Avars, and Turks went forward, and the facts respecting them in Chinese history are, taken altogether, more abundant than upon any other foreign stock of nations. "Hence there is every inducement for the historical ethnologist to study Chinese history carefully."

Messrs. Macmillan and Co. will publish immediately a work on the "Elements of Thermal Chemistry," by Mr. M. M. Pattison Muir, assisted by Mr. D. M. Wilson. It is intended to present a connected account of the methods and results of the most important researches in the subject. Dealing rather with principles than with details, it is adapted for the use of students with a fair knowledge of the principles of Chemistry and the outlines of the study of Energy. The book is divided into two parts—the first devoted to the statement and consideration of the various branches of thermal chemistry; the second comprising most of the data on which the science is built. These data are classified and tabulated in five appendices, which it is hoped will prove of considerable service to students.

A NEW and thoroughly revised edition of Mr. H. B. Woodward's "Geology of England and Wales" is announced. The author has devoted nearly all his leisure hours since 1876 to the preparation of it, sparing no pains to render it as complete and accurate as possible. While giving prominence to the general description of the rocks, their leading fossils, and economic products, some details will be inserted to show the chief variations of the strata when traced across the country. Numerous tables and diagrams will also be given, to show the relations of the larger groups and of the local and minor divisions of each series of stratified rocks. The history of each rock-name, and its synonyms, so far as possible, will be briefly noted. The endeavour is made to explain every local rock-name, as well as the terms applied to particular beds or zones of fossils. The account of the geology of the principal lines of railway will be very much enlarged. The book will be published by subscription. Mr. Woodward's address is 7, Kelvin Terrace, Highbury Park, N.

THE additions to the Zoological Society's Gardens during the past week include a Levaillant's Cynictis (*Cynictis levaillanti* ♂) from South Africa, presented by Mr. W. Hope; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus* ♀), a Wedge-tailed Eagle (*Aquila audax*) from Australia, presented by Mr. G. T. Wills; a Cape Buffalo (*Bubalus caffer* ♂) from South Africa, presented by Mr. J. Gorton; two Cape-crowned Cranes (*Balearica chrysopelargus*) from South Africa, presented by His Excellency Sir Henry E. Bulwer, G.C.M.G.; a Goshawk (*Astur palumbarius*), European, presented by Mr. W. H. St. Quintin; an Indian Kite (*Milvus govinda*) from India, presented by Mrs. E. C. Mathews; a Cerastes Viper (*Vipera cerastes*) from Moses' Well, Arabia, presented by Lieut.-Col. G. W. Smith; two Moose (*Alces machlis* ♂ ♀) from Norway, a Blue and Yellow Macaw (*Ara ararauna*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, four Gold Pheasants (*Thaumalea picta* ♂ ♂ ♀ ♀) from China, deposited; two Ring-tailed Lemurs (*Lemur catta* ♂ ♂) from Madagascar, two Aldrovandi's Skinks (*Plestiodon auratus*) from North-West Africa, purchased; three Lions (*Felis leo*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE DEARBORN OBSERVATORY.—Prof. Hough's report to the Directors of the Chicago Astronomical Society is as usual chiefly occupied with the observations of Jupiter which have been made with the great refractor. The great red spot still forms, of course, the object of greatest interest. The curious filling up which it underwent last February, whereby for a time it presented the appearance of a reddish elliptical ring, with a white centre, is described, and also its gradual return to its normal appearance. The red spot has now been watched for seven years, and during that time its latitude, shape, and size have undergone but little change. The length, however, appears to have diminished slightly in 1884 as compared with 1883, Prof. Hough's measurements being 12"·29 for 1883, and 11"·26 for 1884. The breadth, on the other hand, seems somewhat greater, so that it is less markedly elliptical than in former years. The mean rotation period for the interval 1884 September 25 to 1885 June 29 was found to be 9h. 55m. 40·4s., or somewhat greater than in previous years. "The depression in the equatorial belt under the red spot, which was formed in 1882, has continued, but is gradually being obliterated." "The principal equatorial white spot which has been observed since 1879 was not so conspicuous as in former years." The old rotation value, 9h. 50m. 9·8s., satisfied the observations.

Of other observations the principal recorded are the discovery of thirty-nine new double stars, an observation of the companion to Sirius, 1885·195, Dist. = 7"·96, Posn. Angle = 32°·7, and a series of photographs of the sun taken during the partial eclipse of 1885 March 16. Prof. Hough describes a printing chronograph which he has had constructed, and which records at once the time of an observation to the hundredth of a second, and obviates the labour now necessary to convert the ordinary chronographic record into numbers. He estimates the pecuniary value of this labour in a first-class observatory as at least 200*l.* annually.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, DECEMBER 6–12

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 6

Sun rises, 7h. 53m.; souths, 11h. 51m. 22·3s.; sets, 15h. 50m.; decl. on meridian, 22° 34′ S.: Sidereal Time at Sunset, 20h. 52m.

Moon (New) rises, 7h. 18m.; souths, 11h. 51m.; sets, 16h. 21m.; decl. on meridian, 17° 34′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	9 36	13 18	17 0	24 55 S.
Venus	11 16	15 17	19 18	22 12 S.
Mars	23 11*	6 0	12 49	8 48 N.
Jupiter	1 8	7 12	13 16	0 5 S.
Saturn	17 19*	1 28	9 37	22 25 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Dec.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
11	18 Aquarii	6	20 31	21 30	166 306
12	B.A.C. 7697	6½	17 56	18 56	88 355

Phenomena of Jupiter's Satellites

Dec.	h. m.		Dec.	h. m.	
6	5 19	I. tr. ing.	10	4 27	II. ecl. disap.
6	7 35	I. tr. egr.	10	5 26	IV. tr. ing.
7	1 31	I. ecl. disap.	10	7 30	IV. tr. egr.
7	4 56	I. occ. reap.	12	1 59	II. tr. ing.
8	2 4	I. tr. egr.	12	4 47	II. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, December 6.—Outer major axis of outer ring = 46"·2: outer minor axis of outer ring = 20"·1: southern surface visible.

Dec.	h.	
8	6	Mercury in conjunction with and 6° 3′ south of the Moon.
9	7	Venus at greatest elongation from the Sun, 47° east.
9	15	Mercury stationary.
10	23	Venus in conjunction with and 5° 56′ south of the Moon.

Variable Stars

Star	R.A.	Decl.	Epoch	Phase
	h. m. s.	° ′	h. m.	
U Cephei	0 52 8	81 15·3 N.	Dec. 9, 2 46	*m*
Algol	3 0 41	40 30·7 N.	Dec. 7, 19 46	*m*
λ Tauri	3 54 19	12 9·9 N.	Dec. 9, 17 54	*m*
S Cancri	8 37 22	19 26·8 N.	Dec. 12, 4 52	*m*
X Sagittarii	17 40 19	27 47·1 S.	Dec. 8, 21 30	*m*
η Aquilæ	19 46 37	0 42·7 N.	Dec. 7, 7 0	*M*
			,, 12, 2 30	*m*
δ Cephei	22 24 54	57 49·6 N.	Dec. 7, 1 0	*M*
			,, 10, 20 30	*m*

M signifies maximum; *m* minimum.

Meteor Showers

The two principal showers of this week are the Taurids II., radiant R.A. 80°, Decl. 23° N., near ζ Tauri; and the Geminids, radiant near α Geminorum; the former should be specially looked for on December 6, the latter December 9-12. Fire-balls have frequently been seen during the latter period. Another shower from Taurus, R.A. 56°, Decl. 6° N., near ν Tauri; and another from Gemini, R.A. 108°, Decl. 20° N., near ζ Geminorum, have also been sometimes observed during this week.

Objects with Remarkable Spectra

257 Schj.—R.A. 21h. 50m. 58s., Decl. 49° 57'·2 N. Mag. 9·1 Secchi's fourth type. The dark band in the yellow is abnormally broad.

19 Piscium.—R.A. 23h. 40m. 31s., Decl. 2° 51'·0 N. Mag. 6·2. One of the finest examples of the fourth type of spectrum.

Mr. Marth has called attention to the following conjunction of Saturn with DM. 22° 1383, which should be watched, as it may possibly prove to be an occultation:—

	h.			
Dec. 9 ...	16·4	✳ ☌	with *p* edge of ring,	$y = -\ 8''\cdot0$
	18·4	✳ ☌	with centre of Saturn,	$y = -12\cdot2$
	20·5	✳ ☌	with *f* edge of ring,	$y = -16\cdot4$

The magnitude of the star is 8·7.

GEOGRAPHICAL NOTES

THE *Invalide Russe* publishes the following telegram from Col. Prjevalsky from Pishpek, but dated Karakol, 2nd (N.S. 14th) November:—"Our voyage has ended happily, and with the most encouraging scientific results."

AT the meeting of the Paris Geographical Society on the 20th ult., M. Alphonse Milne-Edwards in the chair, the return of M. de Brazza was announced, as well as his promise to read a paper before the Society on his journeys in the Congo. The President also reported the return of M. Aubry from more than two years' exploration in Choa and part of the country of the Gallas, Danakils, and Somalis. During that time he determined the course of the Haouach River and its affluents, the Mongueur, Goudredet, and Ganjad, as well as the heights of various mountains. He was also able to make numerous observations on the geology, palæontology, and mineralogy of the region. M. Duveyrier stated that the altitude of Fez, which has never before been determined, is about to be calculated by M. Feraud, by the barometer, to within 10 metres. He has found it necessary to make no fewer than 127 observations in order to obtain this result. M. Coudreau referred to the latest stage of the dispute between France and Brazil with regard to the territory lying between French Guiana and Para.

THE *Bulletin* (1885, No. 5) of the Belgian Society of Geography contains a long paper by M. Leclercq on Mexico, which is really a translation and *résumé* of a recent Mexican publication. The present paper is arranged under the following heads:—Situation and boundaries, institutions, political divisions and population, ethnography, with an approximate census of the Indian tribes, industries, railways, and other methods of communication, orography, climate, and productions. It is thus, it will be perceived, a tolerably complete account of the Mexican States.

THE *Boletin* of the Geographical Society of Madrid for October (vol. xix. No. 4), is, as might be expected, mainly occupied with the Caroline Island question. The only map attached to the number is one of the Western Pacific from the Philippines on the west and New Guinea on the south, including the Pelew, Caroline, Marshall, Gilbert, and Ladrone or Marianne groups. The first contribution is a letter from the Society by its authorised officers to the Government on the question, and claiming the islands as belonging historically to Spain.

IT is stated that an accurate survey of the Island of Yezo, and the neighbouring islands (especially the Kuriles), is to be made by the Japanese Naval Department. It is anticipated that the work will occupy four years.

AN Exhibition of Appliances used in Geographical Education in England and on the Continent will be opened by the Royal Geographical Society at 53, Great Marlborough Street, on December 9, and will remain open till January 31.

THE latest numbers of the *Verhandlungen* of the Berlin Geographical Society (Band xii. Nos. 7 and 8) contain papers by Dr. Penck, on the mountain systems of Central Germany; and by Dr. Schulz, on a journey from Port Natal to the Kalahari, and especially the exploration of the Rivers Chobe and Cubango. Dr. Rath (in No. 8) contributes a geographico-geological study of the Pacific regions of North America, and the substance of a lecture by Dr. Buchner on the Cameroons is also given.

A CORRESPONDENT with General Scratchley in New Guinea reports that Mr. H. O. Forbes is going to attempt to reach the summit of Mount Owen Stanley, 13,205 feet high, and hitherto untrodden by the foot of man. Mr. Forbes will form a depôt camp at Sogeri, 25 miles inland, and survey, collect specimens, &c., in the neighbourhood of the lower ranges. Next spring, when the weather will be suitable, he will make the attempt to climb to the highest point. He may, the correspondent says, spend several years in New Guinea, for his wife is following him, and his heart is thoroughly in his work.

THE Swedish Society of Anthropology and Geography has commissioned Baron Schwerin, Professor of Geography at the University of Lund, to proceed on a scientific expedition to the Congo, the chief objects being to make geographical, meteorological, botanical, and zoological studies in the new State, and to collect ethnographical objects. Barons Nordenskjöld and Dickson have lent the Expedition a number of valuable instruments. The Swedish Government have requested Prof. Schwerin to report on the commercial opportunities afforded on the Congo and the position of Scandinavian subjects there.

EXPLOSIONS IN COAL MINES[1]

THE address to which the members of the Society of Arts were so good as to afford a favourable reception at the opening meeting of last Session, was in great measure devoted to topics suggested by the International Health Exhibition of that year. Wide as was the scope of that Exhibition, which dealt not only with the necessaries and comforts of life, and the promotion of bodily health in the feeding, clothing, and housing of all classes, but also with the all-important subjects of physical and mental training, the Exhibition of Inventions—which has just terminated a prosperous and, I believe, a very useful career—embraced a wealth of material for study which could bear comparison, as regards extent and interest, with that presented by any one of the great International Exhibitions of former years, the initiation of which we owe to that illustrious Prince whose memory the Society of Arts delights to honour.

I have resisted the temptation to devote this evening to a brief review of some of the chief matters of interest presented by the most prominent sections of the Exhibition, because I entertain a lively hope that a thorough examination of at any rate *many* of these will afford topics for important communications to this Society, and I consequently feel that it would be scarcely just to those who may consent to devote themselves to their preparation, were I to cull specially attractive matter from the mass of information opened up to the student by the achievements demonstrated at the Exhibition. I therefore propose to limit myself in this address to the treatment of some matters relating to only one branch of a division of the Exhibition, namely, the class which deals with machinery and appliances *used in mines*.

I venture to think that this class of subjects has claims to special interest, *because* the mining industry ranks among the most important sources of the wealth and cosmopolitan influence of the Empire; *because* its development and successful pursuit have involved the utilisation of the resources of many branches of applied science, and have taxed the talents and ingenuity of some of our greatest mechanics, and most accomplished physicists and chemists; and, though last, not least, *because* the pursuit entails the encountering of dangers and vicissitudes which will aptly bear comparison with those involved in the careers of the soldier and the sailor. Thrilling and harrowing accounts of great disasters in coal mines direct public attention from time to time to certain special dangers which the miner has to encounter, but the annual reports of H.M. Inspectors of Mines show that there are yet others to which miners in general are daily exposed, which, although they do not attract public attention (partly because of the very circumstance of their constant occurrence, and partly because the sufferers by them meet their deaths in most cases

[1] Address of Sir Frederick Abel, Chairman of Council of the Society of Arts, delivered at the opening meeting, Nov. 18, 1885.—(Abstract by the Author.)

singly), are nevertheless far more formidable in regard to the gross extent of the fatalities attending them, than are coal-mine explosions.

When the late Mr. MacDonald, M.P. for Stafford, made his remarkable speech in the House of Commons, in 1878, advocating the necessity for the more rigorous inspection of coal mines, and supported his arguments with the enumeration of an appalling list of disastrous colliery explosions, it was pointed out by Mr. Thomas Burt, and other members, that explosions did *not* constitute the chief element of danger which the miner had to encounter, and that, while out of 25,000 lives which had been lost in mines since 1851, over 6,000 deaths had been caused by explosions, there were more than 10,000 due to falls of stone and coal in the mine workings, which attracted little or no public attention. Mr. Cowen also pointed out that there was a still larger number of injuries, due to such causes as these, which were never heard of beyond the locality of the disasters, because they were not attended with fatal results at the time, although in the larger proportion of such cases the sufferers were either maimed for life, or died after more or less brief intervals. The Table below, which has been compiled from the annual reports of the Mine Inspectors for the past ten years, shows the total number of deaths annually due to accidents in mines, and the deaths due respectively to explosions, to the falls of roof or sides in mine workings, and to other miscellaneous causes; and it will be seen that even in those years when especially disastrous explosions had occured, the fatalities due to explosions were, with the exception of two years, considerably in the minority, compared with deaths from falls of roof and sides, while—comparing them with the deaths due to all other causes—the latter were invariably much in excess. It is not surprising, however, that the paralysing moral effect exercised upon small mining communities, and the heartrending local misery and suffering which suddenly and simultaneously fall upon many families, should cause coal-mine explosions to command special sympathy, and to call forth public expressions of regret and surprise that the resources of science and of legislative power should have failed utterly to prevent, or even very greatly diminish, such sad disasters, while, on the other hand, the daily occurrence of fatal accidents in the ordinary pursuit of the miner's vocation, attracts little public attention. It has been contended that the classes of constantly recurring accidents, which combine to cause a far more formidable

STATEMENT OF PROPORTION, AT COLUMN II., OF DEATHS FROM EXPLOSIONS IN COAL MINES, FROM FALLS OF ROOF AND SIDES, AND FROM OTHER MISCELLANEOUS CAUSES, TO TOTAL DEATHS IN MINES FROM ALL CAUSES DURING THE YEARS 1875–1884[1]

Year.	Total Number of Deaths from Accidents of all kinds.	No. of Deaths from: Explo-ions of Fire-damp.	Roof and Sides falling.	Other causes.	Results of some of the more disastrous Explosions in each year.	
1875	1244	288	459	497	Explosion at the Swaithe Main Colliery, near Barnsley	143 lives lost.
					,, Bunker's Hill Colliery, Stoke-on-Trent	43 ,,
					,, New Tredegar Colliery, Monmouthmouth	23 ,,
					,, Llan Colliery, near Cardiff	16 ,,
1876	933	95	449	389	,, South Wales Collery, Abertillery	23 ,,
1877	1208	345	448	415	,, Blantyre Colliery	207 ,,
					,, Pemberton Colliery, near Wigan	36 ,,
1878	1413	586	469	358	,, Abercarn Colliery, Monmouthshire	268 ,,
					,, Wood Pit, Haydock	189 ,,
					,, Apedale Colliery	23 ,,
					,, Barwood Colliery, Kilsyth, near Glasgow...	17 ,,
1879	973	184	426	363	,, Dinas Colliery, Pontypridd	63 ,,
					,, Blantyre Colliery	28 ,,
					,, Stanley Colliery, near Wakefield	21 ,,
1880	1318	499	462	357	,, Seaham Collery	164 ,,
					,, Risca Colliery	120 ,,
					,, Penygraig Colliery	101 ,,
					,, Leycett Colliery	62 ,,
1881	954	116	450	388	,, Abram Colliery, Wigan	48 ,,
					,, Whitfield Colliery, Tunstall	25 ,,
1882	1126	250	468	408	,, Trimdon Grange Colliery, Durham	74 ,,
					,, Tudhoe Colliery, Durham	37 ,,
					,, Clay Cross Colliery, Derbyshire	45 ,,
					,, Baddesley Colliery, Warwickshire	23 ,,
					,, West Stanley Colliery, Chester-le-Street	13 ,,
1883	1054	134	469	451	,, Altham Colliery, Lancashire	68 ,,
					,, Wharncliffe Carlton Colliery, near Barnsley	20 ,,
1884	942	65	482	395	,, Pochin Colliery, near Tredegar, Monmouthshire	14 ,,
					,, Naval Steam Coal Colliery, Penygraig	14 ,,

[1] The facts embodied in the above Table have been long accessible to all who care to inform themselves correctly, by reference to the published annual reports of H. M. Mine Inspectors; it is, therefore, somewhat surprising to find that the Manchester Correspondent of the *Times*, to whose views that journal appears to attach much weight, and whose evident acquaintance with high authorities in matters relating to coal mines, such as Mr. Ellis Lever, should have, at any rate, assisted him to a knowledge of the existence of those reports, is ignorant of the truth relating to a subject with which he deals in a fashion somewhat over-authoritative for the representative of "unenlightened earnestness," which is "impatient" to learn the reason for "hesitation" on the part of a Royal Commission on mine accidents in promulgating its conclusions, is "incredulous of the difficulty of speaking out," and indignantly regards "the delay as a national scandal." In support of this somewhat strong expression of sentiment, "unenlightened earnestness" inquires whether it has "really needed so long to dispel any doubt that shot-firing, for instance, is the commonest cause of the loss of life in coal mines."

total of deaths than even an unusual succession of serious explosions, are to a great extent made up of unavoidable sources of danger to which the miner must be exposed; and that, on the other hand, the causes which lead to explosions have been long known, and can be readily grappled with and removed by the colliery owner or manager. But as a matter of fact the nature of some of the chief and most prevalent conditions favourable to mine explosions is only now being thoroughly made clear, and the same may be said of the nature of measures and appliances by which explosions may be avoided or diminished in magnitude.

From the foregoing considerations, it is evident that very great interest and importance must attach to any decided improvements in systems of working, or in appliances connected with mining, and bearing directly upon the safety, facility, and degree of comfort, with which subterranean operations can be carried on. The members of the Society of Arts will, therefore, I feel sure, take a lively and sympathetic interest in the statements and observations which I have to offer in connection with the Mining Section of the late Exhibition, and, in reference to the labours, now fast drawing to a close, of a Commission, appointed by Her Majesty about six and a half years ago, to inquire and report whether the resources of science could furnish any practical expedients, not then in use, calculated to prevent the occurrence of accidents in mines, or to limit their disastrous consequences; a Royal Commission whose earnest and disinterested labours have been patiently, steadily, and faithfully pursued to successful issues, in spite of engrossing official public and professional duties, and undeterred by the public censure and abuse with which the persevering efforts of its members to complete, as far as practicable, the heavy task allotted to them, have as yet been alone encouraged.

The display at the recent Exhibition of implements and appliances connected with mining, was sufficiently comprehensive to be fairly representative of the nature of improvements which have of late been accomplished in almost all directions. Some of the exhibits demonstrated very important progress made since the Accidents in Mines Commissioners commenced their labours, and are traceable in several instances to certain results of those labours, which, though not formally communicated to the public, have become known to many engaged in the management and supervision of mines.

An examination of the evidence taken by the Commission, and published with their Preliminary Report, showed that there were several important subjects connected with the safe and efficient working of mines upon which large differences of opinion prevailed. This was especially the case with reference to the employment of naked lights in mines—the relative merits of well-known safety lamps—the uses of gunpowder or other explosives underground—and the possible influence of coal-dust in the development or extension of explosions. It was, therefore, especially in these directions that the Commissioners considered it their paramount duty to pursue experimental inquiries, and, as those investigations proceeded, their importance and the useful results likely to emanate from them became the more apparent, while each succeeding step demonstrated the necessity for proceeding further in the inquiries, so that, even up to this, the period fixed by them for the completion of their final Report, the Commissioners have found themselves still engrossed in experiment.

Without presuming to deal in anticipation with the conclusions arrived at by my colleagues and myself as the results of our protracted investigation, I may venture to indicate the nature of some of those results sufficiently to illustrate the progress made in certain matters most vitally affecting the safety of the miner.

The important advances which have of late been made in the methods of operation, and mechanical appliances, provided for exploring and for breaking ground, were illustrated in the Exhibition by some of the most recent improvements in boring and drilling machines, and in the construction of the more ordinary hand tools. Without dwelling upon the marked advance which has been made in the operations of deep-boring and of tunnel-driving, by combining the utilisation of steam or compressed air with the method of continuous flushing, special reference must be made to the great improvement effected in mining operations by the use of drills or perforators driven by compressed air, of which several varieties were shown at South Kensington.

So-called coal-cutting machines, for holing or undercutting coal, of which many forms have constituted prominent features in the mining sections of former Exhibitions, were only represented by one variety on the present occasion, and appear to have hitherto made little way, although their use would seem to be attended with some decided advantages. Hydraulic pressure has been applied with some degree of success in connection with drilling machines and with the forcing down of coal; thus, Messrs. Dubois and François have applied a very efficient hydraulic arrangement, called the *Bossoyeuse*, with considerable practical success, to the removal of rock or stone in mines where fire-damp exists. As regards the different methods of working seams of coal, and the variety of circumstances which determine their expediency or relative merits in different cases, I must limit myself to the statement that the so-called *long wall* system, which consists in the continuous excavation of the coal throughout or along a considerable distance of the breadth of the seam, the excavated part being filled up, as the work advances, with stone and slack, or with material brought from the surface, presents facilities for securing efficient ventilation, and other advantages in regard especially to the safety of the workmen, by which it recommends itself for choice wherever it is applicable, and which, supplemented by the employment of wedges, have been used successfully for bringing down coal or rock in some localities where fire-damp is prevalent.

Large as is the proportion which accidents arising from falls of roof and sides in mine-workings bear to casualties of all other descriptions, an examination of the Mine Inspectors' Casualty Returns happily shows that a considerable improvement has actually taken place in the death-rate from falls during the last twenty years. This is unquestionably owing to bestowal of increased care upon the proper support, by timbering or arching, of the roof and sides of many workings, or upon improvements in the system upon which this most important work is carried out. Cheering as these results are, it cannot be doubted that much remains to be accomplished in order to reduce the proportion of casualties from these causes to some approach towards what might be reasonably accepted as unavoidable at the present day.

One great safeguard to the miner against accidents from falls of stone and coal would obviously be the provision of efficient illumination of the ways and working places. A powerful excuse for the use of naked lights, even where risk of producing explosions was known to be incurred thereby, has been sought, and even sometimes admitted, in the necessity for more light in insecure places than that furnished by the Davy, the Geordie, or the Clanny lamp; the argument against enforcing the general adoption of safety lamps, most strongly urged by Mr. Burt and others in the debate of 1878, was the miserable insufficiency of the light afforded by them, and the consequent increase in the number of accidents due to causes other than explosions. Among improvements of late effected in the construction of safety lamps, has been the increase of their illuminating power; and this subject of underground illumination is, I may confidently say, ripe for very great amelioration.

The simple modes of underground transport of coal by manual or horse labour have now, to a very considerable extent, given place to its haulage, along tramways, by means of wire ropes or chains actuated either by steam hauling engines placed near the pit bottom, or by compressed air-engines stationed in different parts of the main roads. Some good illustrations of hauling machinery of these kinds were included in the Exhibition, and members of the Society of Arts cannot fail to remember with interest that our late lamented chairman, Sir William Siemens, was the pioneer in the introduction of electric hauling arrangements for mining work.

A fruitful source of disaster connected with mines has been the descent or ascent of the men by the shafts, and many contrivances have been devised, and more or less extensively applied, for preventing accidents resulting from the overwinding of the cages in which the men and the coal are brought to the surface, or from the fracture of the rope with which these cages are worked.

Really efficient and trustworthy appliances of this class cannot fail to be important safeguards, equally perhaps with those afforded by great improvements which have been effected in the construction and quality of the hauling- or pit-ropes. It is impossible to overrate the necessity for the bestowal of the highest skill and care upon the manufacture, testing, and periodical inspection of these all-important adjuncts to mining work, to which many thousands have daily, in blind confidence, to trust their lives.

The great improvements which have been effected in the steam brakes and reversing gear applied to the powerful winding-engines which, as monuments of mechanical skill, merit the careful inspection of all interested in mining industry, are most important additions to the safety appliances provided in the present day in connection with the pit work of our mines. To these must be added the improvements made in signalling arrangements from the surface and underground, in connection with which electricity has of late commenced to play an important part.

The great advance made in the *ventilation* of mines during the past half century is well known to all who have paid the least attention to these matters. Not only has the ventilating furnace been greatly improved in efficiency and power; the steam jet and compressed air have received important application within the last thirty-six years, and fans, and other mechanical ventilating agents of great power have come into extensive use during the past twenty-three years.

The proper distribution of the air which is drawn down into the pit, and the arrangements necessary for insuring the distribution of fresh air throughout the different roadways and workings in a mine, and its isolation from return- or foul air-currents which are passing to the upcast or exit shaft, are now carried out effectually in a large proportion of our coal mines.

Although we have long been familiar with the nature of fire-damp, and with the generally-accepted explanation of its origin in coal, considerable uncertainty and consequent diversity of opinion still prevail as to the condition in which the gas is pent up in coal, and in the associated strata. That the light carburetted hydrogen, which chiefly composes fire-damp, exists, with its associated gases, in a more or less condensed condition, in coal, even some time after removal from the pit; and, that the gradual escape of the condensed inflammable gas from coal has constituted a fruitful source of disaster to coal-laden ships, and to steam-vessels carrying a large provision of coal—such as our ships of war—are very well known facts; but, there are constantly-recurring phenomena connected with the escape of gas from coal, a really satisfactory explanation of which is still wanting, although patient inquiry has long been devoted to its discovery. Thus it has been demonstrated by experiment that, if cavities are bored into the coal and plugged, the gas will speedily accumulate so as to exercise a pressure of several hundred pounds upon the square inch, as indicated by pressure-gauges fixed into the cavities.

In some localities, the gas issues as a jet, or so-called "blower," and many of these furnish a continuous supply of gas under fairly uniform pressure, which may be conducted in a steady stream to the surface, and utilised for heating and even for illuminating purposes. Many explanations have been offered of the existence of these blowers, and of the maintenance and sudden cessation of the gas supply, but they have remained a mystery.

The systems of ventilation now in use in coal mines, and the powerful circulation of air maintained thereby, deal effectually with the removal of gas, as it exudes from *freshly-worked* coal even in very fiery mines, when it passes into the main ways and the workings which are actually in use; but, in *old workings*, recesses, or cavities, and in the so-called goaves, where the worked-out space has been filled up with stone and *débris*, the gas may lurk and lodge, and may at any time constitute a source of great danger, if special means are not adopted to favour its removal; and, even with the most efficient and searching ventilating arrangements, the almost unavoidable existence of some accumulations here and there in mines where fire-damp is prevalent, renders absolute freedom from it, of the air in the mine, practically unattainable in such cases, although the amount diffused through the atmosphere may seldom, under ordinary conditions, approach, even distantly, to the minimum proportion which, *per se*, might constitute a source of danger.

It is now generally admitted that variations of atmospheric pressure influence the tendency of fire-damp to escape from goaves or old workings in a mine where accumulations are liable to exist, and that when a reduction of pressure suddenly sets in, such an escape may take place even to some considerable extent before the barometer indicates the depression. Some even maintain that the emission of gas from the fresh face of coal is considerably promoted by such alterations of pressure; but although there are many undoubted instances of explosions having occurred during sudden and very considerable depressions of the barometer, different observers in this and other countries are by no means in accord as to the extent to which, in a properly-ventilated mine, the existence of fire-damp in the air is influenced by barometric changes.

There are some mines so free from fire-damp that naked lights may be used therein with perfect safety, and others where the use of safety lamps need apparently be only insisted upon in certain parts of the workings. There can be no doubt, on the other hand, that the adoption of even the most perfect ventilation cannot secure such absolute safety as to render the use of naked lights warrantable, where seams are worked in which fire-damp exists in any abundance,—because danger may there arise at any time, from some accidental stoppage or partial failure of the ventilating arrangements, from the effect of a reduction of atmospheric pressure in promoting the escape of gas from lurking places, or, from a liability to the sudden emission of gas in considerable quantity from coal. The very poor light furnished by the forms of safety lamp still chiefly in use, has afforded very strong temptation to the men to have recourse to naked lights, and to the managers of mines to regard such proceeding with indulgence, even where its danger is well recognised. Poor as the light is which the older forms of lamps furnish in a quiet atmosphere, it becomes even much worse when they are exposed to such currents as are now met with in properly ventilated mines.

Efficient lamps should therefore burn brightly and steadily even in strong currents of air, and they should be unable, under any circumstances at all likely to arise in coal mines, to ignite an inflammable mixture of fire-damp and air, even when this is passing at the highest velocities which can occur in any part of a mine.

The importance of determining how far modifications of existing lamps, or new kinds, fulfil these conditions, has led individuals specially interested in the subject, and associations of mining engineers, for many years past, to submit lamps to comparative experimental tests; and the first branch of inquiry which was taken up by the Royal Commission was the systematic comparison of the behaviour of different lamps under variously modified conditions in currents of explosive mixtures of gas and air, travelling at different and accurately-determined velocities.

As the experiments proceeded, and the results of tests applied to particular lamps became known to the makers, modifications in construction were introduced, or new arrangements devised. More than 200 lamps have been submitted to a variety of trials, and even up to the present day the Commission have continued to receive new lamps, with urgent requests that they should be included in the trials.

This investigation has also included a careful determination of the amount of light furnished, and of the burning qualities of all the more promising lamps, as well as an examination into their practical merits, in regard to construction, weight, and handiness.

The results of these extensive investigations will now very shortly be in the hands of the public: I must content myself with very briefly indicating their general nature.

Only three types of lamp were until recently in extensive use in this country: the original safety lamps, which the miners owe to the genius of Davy and of Stephenson, and a lamp not long afterwards devised by Dr. Clanny. When the safety lamp was first invented, the ventilating currents in mines were very moderate indeed, and under the then prevailing conditions these earliest lamps were fairly safe. But, at the present time, the air in the mine roadways often travels at a rate of 20 to 25 feet per second, and may even, in some special places, attain velocities of 30 to 35 feet. Under these conditions the Davy and Clanny lamps cease to afford any security in localities where fire-damp is prevalent. This had already been indicated by the results of previous experiments when the Commissioners commenced their work, but their own investigation so clearly established the great danger of these lamps, and the facts already known on the subject appeared to have received so little consideration, that the Commissioners regarded it as their imperative duty to direct the Home Secretary's attention officially and in strong terms to the fact, in the hope that most prominent publicity would be at once given to their warning.

After some delay, a circular embodying the substance of it was issued, but without any indication that it bore the authority of the Royal Commission. This action was taken not long after the appointment of the Commission, yet the Davy and Clanny lamps have continued in use in mines where the elements of danger insisted upon exist.

The Davy lamp had, some years back, been rendered much less dangerous by the addition of a metal shield partially surrounding the gauze cylinder, or by the provision of an external glass cylinder extending up the gauze to various distances. The latter modification proved to be the most efficient safeguard of the two; but a much more important protection has been comparatively recently effected by inclosing the lamp in a case, which protects it to a great extent from the action of currents, though this considerably diminishes the already very meagre light afforded by this lamp.

A lamp of Belgian origin, termed the *Mueseler*, and which has for many years past been officially adopted in Belgian mines, presents important advantages over the lamps already referred to, which were, in part, recognised before the Commission existed, the lamp having since come into somewhat extensive use. Some experiments and certain results of practical experience had, however, already thrown doubt upon the wisdom of placing absolute reliance in the safety of this lamp; the Commissioners' experiments confirmed the validity of those doubts, and showed that, under particular conditions, the Mueseler lamp might cause an explosion when exposed to a current of fire-damp mixture of very moderate velocity. On the other hand, the *cased Davy* lamp was found perfectly safe, under much more severe conditions, and this important fact has led to the adaptation of cases in various ways to the old types of safety lamps—many so-called new safety lamps consisting, in fact, of the Davy and Clanny protected by inclosure from the direct action of the current.

The publication of the Commissioners' investigations will, I venture to affirm, convince even those who, although they have not cared to inform themselves of the character and extent of the work which was being done, have thought it right and just to publicly reproach the Commission with dilatoriness, that the curtailment of these researches would only have been detrimental to the conclusive, and therefore practically important, nature of the results arrived at. For, these have not only led to decisive conclusions regarding the defects of the best known types of lamps, and the degree of safety and other merits of a large variety of modifications of them, as well as of new forms of lamps, but they will also enable the Commissioners to indicate, with confidence, several lamps which combine a great degree of safety with other important merits, and to specify a few among these which, while ranking highest in point of safety, and leaving very little indeed to be desired in this respect, combine, with this first essential, the important adjuncts of simplicity of construction and fair illuminating power. It will, moreover, be possible to indicate some directions in which even these lamps are susceptible of improvement. It, therefore, only remains to be hoped that the results of the labour which the Commissioners have devoted to this branch of their inquiry will be accepted wtth the confidence they merit, and will be speedily utilised both by those who are responsible for the management of mines and by those who control the actions of the miner.

When the Commission's investigations were already considerably advanced, Mr. Ellis Lever publicly offered a premium of £500 for a miners' safety lamp, which, while being of convenient size for carrying about, would continue to give a useful amount of light for not less than twelve hours, *and which would not cause an explosion of gas under any circumstances at all likely to represent conditions which may occur in actual practice.* It was proposed that the judges to whom lamps submitted for competition were to be referred should include three scientists, nominated respectively by Mr. Lever, by the Royal Society, and by the Society of Arts. No less than 108 different lamps were sent in, and it need scarcely be said that the determination whether any among them fulfilled the prescribed conditions involved a very extensive series of experiments. The adjudicators who had to investigate the merits of the various lamps, included three scientists, and two were members of the Commission, who cheerfully consented to take upon themselves this very considerable addition to the voluntary labours already being carried on by them in the interests of the miners.

Only four electric lamps were submitted, and these altogether failed in fulfilling any one of the conditions laid down, excepting that of being self-contained lamps. Eventually, not one of the other lamps was found completely to fulfil the whole of the conditions under which the premium was offered, although several ranked very high as regards safety and efficiency; foremost among these being the lamp of M. Marsaut and that of Mr. N. Morgan, of Pontypridd, to whom gold medals have been awarded at the Inventions Exhibition, and whose lamps rank among those which the Commissioners are able to speak most highly of. But, the premium which Mr. Lever placed at the disposal of the adjudicators reverted to him, and those who have great experience of the behaviour of safety lamps of the various well-known and recently developed types, could scarcely have anticipated a different result. Mr. Lever has, since then, again offered a similar premium, this time for "the invention or discovery of an economical, efficient, and safe substitute for gunpowder and other dangerous explosives used in the getting of coal." The Council of the Society of Arts could not see their way to comply with the suggestions of Mr. Lever that they should award this premium, or appoint adjudicators for that purpose, as they did not feel themselves warranted in suggesting the great sacrifice of time, in the performance of the very laborious and exhaustive experiments indispensable in this case, to such as would be really competent to perform the work of adjudication, which Mr. Lever appears to think at least as lightly of as of the offer of these prizes. It borders upon the amusing to observe in the article by the Manchester Correspondent of the *Times*, to which such prominence was given on the 27th of last June, how the writer heralds offers of subscriptions and of premiums, as illustrating the way in which his hero "gallantly attacks the problem (of accidents in mines) at all points," while he has no encouraging word for the man of science whose disinterested devotion to very arduous work, for which his sole probable recognition would be hostile criticism, or worse, can alone give any point to the "gallant attacks" of philanthropists like Mr. Ellis Lever.

(*To be continued.*)

THE ROYAL SOCIETY[1]

AT the earliest opportunity after my return to England last spring I offered my very grateful acknowledgments to the Society for the kindness with which the Fellows had condoned my enforced absence from my post during the winter. And I should not venture to occupy your time by recurring to the subject, did not the return of St. Andrew's Day admonish me that duty and inclination alike require me to offer my especial thanks to the Treasurer for the cheerful readiness with which he took upon himself the burden of my duties, and the efficiency with which he discharged them on our last Anniversary.

On the last occasion on which I had the honour to address you, it was my painful duty to commence by lamenting the death of a very eminent member of the Society, who was, at the same time, one of my oldest and most intimate friends. I deeply regret to find myself once more in this position. The lamentable accident which has deprived the Society of one of its oldest and most distinguished Fellows, Dr. Carpenter, has robbed me of a friend, whose kindly sympathy and help were invaluable to me five-and-thirty years ago, and who has never failed me since.

You are all acquainted with Dr. Carpenter's great and long-continued services to science as an investigator and as an expositor of remarkable literary skill; and there must be many here who, having worked with him in the University of London, of which he was so long Registrar, are familiar with the high integrity, the energy, and the knowledge, which marked him as an administrator. He was a man of varied accomplishments outside the province of science, single-minded in aim, stainless in life, respected by all with whom he came in contact.

Within the last few days, Physics has lost an eminent representative in Dr. Thomas Andrews, of Belfast. Among the cultivators of Chemical Science we have to regret the decease of Mr. Field, who was one of the original members of the Chemical Society; of Mr. Weldon, and of Dr. Voelcker, whose names are well known in connexion with manufacturing and agricultural chemistry. In Biology, we have lost Dr. Davidson, whose elaborate monographs on the fossil Brachiopoda are remarkable examples of accurate malacological work combined with artistic skill; Dr. Gwyn Jeffries, the veteran explorer of our marine molluscous fauna, and a high authority on conchology; and Dr. Morrison Watson, whose early death has cut short the career of an anatomist of much promise. Mineralogy has suffered a similar loss by the premature death of Dr. Walter Flight. In Engineering Science, we have to lament the deaths of Mr. Barlow and Professor Fleeming Jenkin. I may be permitted to dwell for a moment upon the latter name, as that of a most genial and accomplished man and a valued personal

[1] Address of the President, Prof. T. H. Huxley, delivered at the Anniversary Meeting, November 30, 1885.

friend, with whom it had been my privilege to be associated for a time in his well-directed and successful efforts to improve the sanitary condition of our cities. The elder generation of English geologists will remember the keen interest which the Earl of Selkirk took in their pursuits. The death of Lord Houghton robs us of a connecting link with all the world.

Three very distinguished names have disappeared from the ranks of our Foreign Members: that of Henle, of Göttingen, among whose many merits must stand that of ranking next after Schwann among the founders of histology; that of the venerable Henry Milne-Edwards, of Paris, one of the most distinguished members of the school of Cuvier, and admirable no less for his contributions to zoological philosophy than for the extent and the precision of his additions to our knowledge of facts; and lastly, that of Von Siebold, of Münich, whose remarkable investigations into the phenomena of parasitism and of sexless reproduction brought about the solution of some of the most difficult problems of zoology, while it would be difficult to exaggerate the influence of his wonderfully accurate and comprehensive "Handbook" on the progress of invertebrate zoology forty years ago.

On the 1st of December last year the total number of Fellows of the Royal Society amounted to 519; of these 473 were on the home and 46 on the foreign list. Deducting Her Majesty, our Patron, and four other Royal personages, the number on the home list was 468. At the present moment, we have 49 foreign members, or within one of our full complement; while the total strength of the home list (deducting Royal personages) is 466, or two fewer than twelve months ago. The number of deaths in the home list during the past year is 20. This is a larger mortality than that of last year; and it still exceeds the number of Fellows added to the Society by election, which during the last part of the year was 16: namely, the statutory 15 Fellows elected in the ordinary way and 1 Privy Councillor.

As the Treasurer observed in his address on the last Anniversary, it is obvious that we are rapidly approaching a state of equilibrium between our losses and our gains; and, under the present conditions of election, the strength of the home list may be expected to remain somewhere between 460 and 470.

While our number thus tends to remain stationary, the list of candidates for the Fellowship, though it has fluctuated a good deal from year to year, has on the whole become longer, until, at present, the candidates are more than four times as numerous as the annual elections sanctioned by our rules. This state of things has given rise to comment, both within and without the Society, on more than one occasion. It has been said that any restriction upon the number of our Fellows is unwise, inasmuch as we narrow our influence and diminish our revenues thereby; and, by way of a still more unpleasant suggestion, it is hinted that, by such limitations, we lay ourselves open to the charge of a desire to arrogate to ourselves the position of the elect of science.

With respect to the first objection, I venture to point out that the influence of the Society upon the advancement of science is not by any means measured either by its numerical strength or by the amount of the funds at its disposal.

And, as to the second charge or insinuation, if it is worth while to meet it at all (which may be doubtful), I am disposed to think that, in another than the invidious sense of the words, it is highly desirable that the Fellows of the Royal Society should regard themselves, and be regarded by others, as the elect of science. An organisation which was the direct product of the new birth of science in the days of Gilbert, of Galileo, and of Harvey; which was one of the earliest of the associations founded for the sole purpose of promoting natural knowledge; and which has so faithfully performed its functions that it is inseparably associated with all the great strides which science has made for two centuries, has insensibly and without effort become a recognised representative of men of science in these islands: as such, on the one hand, it is consulted by the Government on scientific questions; and, on the other hand, it claims the right to be heard by the Government on all questions of scientific interest. I believe it to be impossible that the Society should discharge the functions which it has not sought, but which have thus devolved upon it, satisfactorily, unless it really does consist, in one sense, of the elect of science; that is to say, unless every care is taken to keep its scientific character at the level of its scientific reputation, and to ensure that it shall be not the mere figure-head of the scientific body, but a living association of representative men engaged in all branches of scientific activity.

Those among my hearers whose memories go back forty years will remember that, at that time, the Society was in great danger of losing its scientific character, though it would doubtless have taken it a long time, and a good deal of perversity, to get rid of its scientific reputation. It had become the fashion to append F.R.S. to a name, and the scientific members where in danger of being swamped by the invasion of *dilettanti*. The aim of our eminent colleague, Sir William Grove, and his friends, who fought the battle of 1847, and thereby, to my mind, earned the undying gratitude of all who have the interests of science at heart, was not to create an academy of immortals, but to save the Fellowship of the Society from becoming a sham and an imposture. And they succeeded in their object by carrying a measure of reform which embodied two principles—the first, that of the practical responsibility of the Council for the elections, the second, that of the limitation of the number of candidates annually elected. The result of the steady adherence of the Society to these principles for thirty-eight years is that, year by year, the Society has approached more and more closely to that representative character which, I cannot but think, it is eminently desirable it should possess.

During a great part of this time I have enjoyed more and closer opportunities than most people of watching the working of our system. Mistakes have been made now and then, no doubt, for even members of Council are fallible; but it is more than thirty years since the propriety of the selections made by the Council has been challenged at a general meeting; and I have never heard a question raised as to the conscientiousness with which the work is done, or as to the desire of the Council to mete out even-handed justice to the devotees of all branches of science. I am very strongly of opinion that if the Royal Society were a "Chamber of Science," subject to dissolution, and that after such dissolution a general election, by universal suffrage of the members of all scientific bodies in the kingdom, took place, an overwhelming majority of the present Fellows would be re-elected.

Such being my conviction, it is natural that I should express a fervent hope that the Society will never be tempted to depart from the principles of the method by which, at present, it recruits its strength. It is quite another question, however, whether it is desirable to retain the present limit to our annual addition or to increase it.

There is assuredly nothing sacred in the number 15; nor any good reason that I know of for restricting the total strength of our home list to 460 or 470; so long as our recruits approve themselves good soldiers of science the more we enrol the better. And if I may pursue the metaphor, I will add that I do not think it desirable that our corps should consist altogether of general officers. Any such exclusiveness would deprive us of much useful service, and seriously interfere with the representative character in which our strength lies. I think we ought to be in touch with the whole world of science in the country, and constitute a microcosm answering to that macrocosm. Those who are in favour of making a change observe that the limit of fifteen was fixed nearly forty years ago; that the number of those who occupy themselves seriously with science and attain a position which would undoubtedly have brought them into the Society at that time, has increased and is constantly increasing; and that it is undesirable that we should be compelled to leave out of our body, year after year, persons whom we should be very glad to see in it. On the other hand, it is to be recollected that a change once made can hardly be revoked, and that, in view of the importance of such a step, the Society will do well to make sure of the consequences before taking it.

I have thought it desirable to raise the question, not for the purpose of suggesting any immediate action—for my personal opinion is that, at present, no change is desirable—but in order that the attention of the Fellows may be directed to a matter which I think is sure to come before them in a practical shape before many anniversaries go by. And, whenever that time arrives, I think another problem may possibly offer itself for solution. Since this Society was founded, English-speaking communities have been planted and are increasing and multiplying in all quarters of the globe—to use a naturalist's phrase, their geographical distribution is "world wide." Wherever these communities have had time to develop, the instinct which led our forefathers to come together for the promotion of natural knowledge has worked in them and produced most notable results. The quantity and quality of the scientific work now being done in the United States moves us all to hearty admiration; the Dominion of Canada, and our colonies in South Africa, New Zealand, and Australia, show that they do not mean to be left behind in the race; and the scientific activity of our countrymen in India needs no comment.

Whatever may be the practicability of political federation for more or fewer of the rapidly growing English-speaking peoples of the globe, some sort of scientific federation should surely be possible. Nothing is baser than scientific Chauvinism, but still blood is thicker than water; and I have often ventured to dream that the Royal Society might associate itself in some special way with all English-speaking men of science; that it might recognise their work in other ways than by the rare opportunities at present offered by election to our foreign Fellowship, or by the award of those medals which are open to everybody; and without imposing upon them the responsibilities of the ordinary Fellowship, while they must needs be deprived of a large part of its privileges. How far this aspiration of mine may be reciprocated by our scientific brethren in the United States and in our colonies I do not know: I make it public, on my own responsibility, for your and their consideration.

I am anxious to call the attention of the Fellows to an alteration in our rules, in virtue of which it is hoped that the valuable library of the Society will be made more extensively useful to them by being accessible up to a later hour than heretofore, and by better provision for the comfort and convenience of those who desire to read or write in the Society's rooms.

The funds of the Society have been augmented in various ways during the past year.

The value of the fee for the Croonian Lecture has been increased from 2*l.* 18*s.* 9*d.* to about 50*l.* a-year, by the falling in of certain leases.

Allusion was made in the Treasurer's address last year to the Darwin Memorial. I am happy to say that Mr. Boehm's admirable statue was formally and publicly accepted by H.R.H. the Prince of Wales, on behalf of the Trustees of the British Museum, last summer, and now adorns the entrance hall of the Natural History Museum at South Kensington. The balance of the sum raised, amounting to 2000*l.*, has been handed over to the Royal Society, and the interest thereof will be employed under the name of the "Darwin Fund for the Promotion of Biological Research," in any way the President and Council may think fit. I sincerely trust that this fund may be increased from time to time, as the Donation Fund, founded by Dr. Wollaston, has been; and that its beneficent influence on the progress of biological science may thus keep green the memory of the great man whose name it bears, in the way which, assuredly, would have been most agreeable to himself.

I am sure that I may express your acknowledgments to Mr. James Budgett for the repetition of his liberal donation of 100*l.* in aid of the cost of publication of Prof. Parker's important and elaborate monographs on the vertebrate skull, one of which occupies a whole part of the *Transactions*, and is illustrated by thirty-nine quarto plates.

We are indebted to the subscribers to the Henry Smith Memorial for the marble replica of the bust by Mr. Boehm of that eminent mathematician and most accomplished scholar, which now ornaments our library. The Fine Art Society has presented Mr. Flameng's etching of the portrait of your President, painted by the Hon. John Collier.

Among the presents to the library, I may particularly mention the second volume of Prof. G. Retzius' valuable and splendidly illustrated work, "Das Gehör-organ der Wirbelthiere," and "Les Habitants de Surinam," by the Prince Roland Bonaparte, by their respective authors, and four volumes of the *Challenger* Report, by Her Majesty's Stationery Office.

Five numbers of the *Proceedings* (about 880 pages) have appeared since the last Anniversary. Only one part of the *Philosophical Transactions* has been as yet published; but two other parts (Parts I. and II. for 1885) are passing simultaneously through the press.

The possibility of devising means by which papers read before us may be published more rapidly, has seriously engaged the attention of the officers of the Society, and I trust that, before long, the Council may have some well-conceived plan for achieving that end brought under their consideration. While all will agree in deprecating unnecessary retardation, it must be remembered that a certain delay is absolutely necessary, if the Committee of Papers is to discharge with due care its important function of arriving at a sound judgment, after considering the opinions of responsible specialists on the merits of each paper submitted to it. In substance, I do not think that we can hope to better our present arrangements; all that can be asked is, that they should be improved in some details, and more especially that the time which necessarily intervenes between presentation and publication should be minimised.

The preparation of copy for the Catalogue of Scientific Papers, decade 1874—85, now approaches completion. A total of 290 series have been indexed, giving 85,000 title slips, written, checked, and distributed. This number, which is within 10,000 of that contained in the two volumes of the preceding decade, nearly exhausts the material in our own library; it remains to supplement this by reference to other libraries.

At the meeting on the 18th of June last, our Fellow, Prof. Roy, communicated to the Council the project entertained by himself, Dr. Graham Brown, of Edinburgh, and Mr. Sherington (G. H. Lewes Student, Cambridge), of proceeding to Spain with a view of investigating the nature of cholera, and requested the assistance of the Royal Society.

In view of the great practical importance of such an investigation, and the desirableness of making a new attempt to solve a problem about which highly competent inquirers have arrived at contradictory results, the President and Council resolved to do everything which lay in their power to assist Dr. Roy and his colleagues. The Secretary was instructed to inquire of the Spanish Minister whether the proposed investigations would be agreeable to the Spanish authorities, and whether Dr. Roy might expect to obtain facilities and assistance. On the receipt of a courteous and sympathetic letter from his Excellency, the Secretary was further instructed to inform the Foreign Office of Dr. Roy's expedition, and to request that Her Majesty's Government would afford him and his colleagues all the assistance in their power. Moreover, 150*l.* was granted from the Donation Fund in aid of the expenses of the undertaking, which were shared between the Royal Society and the Society for the Advancement of Medicine by Research.

I am sure the Fellows of the Society will join with me in congratulating Dr. Roy, Dr. Brown, and Mr. Sherington on having returned safe and sound from an adventure in which the interest of scientific inquiry must have been heightened by a considerable spice of personal danger. Dr. Roy has furnished me with a brief preliminary report of the work done, the substance of which I proceed to lay before the Society.

The members of the Commission met with very serious difficulties in their attempts to study the pathology of cholera in Spain, where they spent three months; but owing to the powerful support which was given them by the English Embassy in Madrid, they were able eventually to pursue their studies in a satisfactory manner. At Aranjuez and Madrid they obtained free access to the cholera hospitals, and made nearly thirty autopsies of typical cholera cases within very short periods after death. From all of these cases they were able to obtain material for cultivation and thus to make a large series of investigations on the different forms of micro-organisms which are found in the tissues and intestinal contents of cholera cases. Owing, however, to the impossibility of obtaining animals for inoculation, and reagents of various kinds, they were unable to complete their inquiry in Spain, and they were obliged to leave the investigations of certain points until their return to England. They have directed their attention chiefly to the relation which the comma bacillus, first described by Koch, bears to the cholera process, and they hope to be able to make important additions to our knowledge of this important subject. They are at present engaged in completing their work, and in the course of a few weeks they hope to be able to present their full report to the Royal Society.

The Marine Biological Association, to the funds of which the Royal Society made a substantial contribution last year, is making good progress. A site for building has been granted by the War Office, at Plymouth; plans have been prepared, and if the Treasury will follow the precedent which it has so largely and beneficially adopted in educational matters, of helping those who help themselves, as I am glad to say my lords seem inclined to do, I trust that, before long, the laboratory will be in working order.

The prosecution of the borings into the Delta of the Nile, which reference has been made on previous Anniversaries, have unfortunately been hindered by various obstacles. Quite recently I have been favoured by Col. H. Maitland, R.E., with an account of the borings made near Rosetta, in which a depth of 84 feet was reached without apparently attaining the bottom of the fluviatile deposits; and I hope that circumstances may shortly permit the resumption of the original project of carrying a line of borings across the Valley of the Nile on the parallel of Tantah or thereabouts.

In the meanwhile the Committee in charge of the investigation has presented a report by Prof. Judd on the results of the examination of the borings already made. I have been favoured by Prof. Judd with the following brief summary of these results, which have been fully fully set forth in a paper read at the first meeting of the Society after the recess.

Although two of the recent borings in the Nile Delta have attained depths of 73 and 84 feet respectively, yet neither of them has reached the rocky floor of the old Nile Valley, nor, indeed, have they afforded any indications of an approach to the solid rock. The samples of the Delta deposits obtained by these boring operations are found to be in all cases mixtures in varying proportions of Nile mud, or material carried in suspension by the river, and desert sand, or particles swept up from the surrounding districts by the action of winds. The study of these materials by the aid of the microscope has revealed a number of facts which may be made the basis of generalisations of considerable interest to geologists.

The minerals present in these sands and muds are found to be such as characterise the granitic and highly crystalline metamorphic rocks; there can be little doubt, therefore, that the vast regions included within the Nile basin are in the main composed of rocks belonging to those classes, or of sedimentary deposits derived from them.

Of still greater interest is the fact that the fragments of felspars and other complex silicates in the Delta deposits exhibit but slight evidences of kaolinisation or other chemical change. This points to the conclusion that, in rainless districts drained by the Nile, the disintegration of rocks is effected by mechanical rather than by chemical agencies. A very striking confirmation of this conclusion is afforded by the study of the composition of the waters of the Nile, our knowledge of which has been greatly advanced by the recent researches by Dr. C. M. Tidy. In spite of the circumstance that the waters of the Nile must undergo great concentration during its passage of 1400 miles through regions of exceptional heat and drought, it is found that those waters actually hold in solution little more than one-half the percentage of mineral matter which is present in the river waters of temperate and rainy regions. The chemical disintegration of rocks being so largely due to the action of rain and vegetation, it is not surprising to find that where these agencies are almost entirely absent the rocks exhibit but few signs of chemical change.

The Krakatão Committee, which is now rather a large one, consisting of thirteen members, has been steadily at work during the year; and the discussion of the very varied and large mass of data has been undertaken by sub-committees, dealing respectively with the following branches:—

Geological—including eruption and earthquake phenomena, and the geological features of the distribution of dust and pumice.

Meteorological (A)—including air-waves, sounds, and the geographical distribution of dust and pumice.

Meteorological (B)—including twilight effects, coronal appearances, cloud haze, coloured sun, moon, &c.

Magnetic and electric phenomena.

Tidal waves.

With the exception of the last-named Sub-Committee, viz. that upon Tidal Waves, of which the work has been delayed by the illness of Sir F. Evans, all the reports are now in a forward state, and there seems to be every prospect of the work being concluded in the course of a very few months.

The question of the proper administration of the funds administered on behalf of the Government by the representatives of the Royal Society and of other scientific bodies, who constitute the Government Grant Committee, has frequently been debated with much care by the President and Council, who are held responsible for the final assignment of the grant by the Government.

On the 20th of May last the Council determined, once again, to devote special attention to the subject, and on the 25th June the minutes will inform you that the following resolutions were passed:—

"That in every case of renewed application for a personal grant, after such grant has been received by the applicant in two consecutive years, the application be made not less than three months before it is to be considered, accompanied by a full statement of the case from the applicant, and that before being presented to the Committee, it be referred by the Council to two referees, who shall report to the Council on its merits."

"That the Secretaries be instructed to return to the applicants for aid from the Government Grant such applications as do not in all particulars comply with the conditions laid down in the circular to applicants."

It is very desirable that our intention to enforce the latter resolution strictly should be widely promulgated. I may add that we have considerable reason to complain that too frequently those who have obtained grants through the Committee make no report of the work done to the Society, but leave information on that head to reach us as it may through the publications in which the results obtained by the grantee are made known.

Nineteen large royal quarto volumes of the Official Reports on the Scientific Results of the *Challenger* Expedition have now been issued from the press. These contain thirty-seven zoological, three botanical, and eight physical and chemical reports, together with the narrative of the voyage, which contains the general scientific results of the Expedition. Six more volumes are now passing through the press, a considerable part of each being already printed off. The work connected with the remaining memoirs is in a forward state. The whole of the investigations and the manuscript will be completed during the next financial year, and in the course of the year 1887 the whole of the Reports will be published, and the work connected with the Expedition brought to a close.

In the Treasurer's address last year the Society was fully informed of the action taken by the President and Council in the matter of the position of this country with respect to the international "Bureau des Poids et Mesures." I am happy to be able to report to the Society that, last December, we received a letter from the Treasury, stating that my Lords had asked the Secretary of State to instruct the British Ambassador at Paris to make known to the Comité International des Poids et Mesures that Her Majesty's Government were willing to join the Convention on the terms described in our Secretary's letter of the 18th August, 1884, and that the proposal had been accepted.

Your President is, *ex officio*, Chairman of the Board of Visitors of the Royal Observatory. As such, it was my duty to preside at a recent meeting of that body, when my colleagues agreed to recommend the adoption of a day, commencing at midnight, in all observatories and in the *Nautical Almanac*, from and after the commencement of the year 1891.

Much to my regret, I have been unable to take part in the work of the City and Guilds Institute during the past year, but I have reason to know that considerable progress has been made towards the attainment of its object—the advancement of technical education in London and in the provinces. The Finsbury Technical College is fulfilling its purpose in the most satisfactory manner, and its day and evening classes are so numerously attended that an extension of the building is under consideration. About 250 technical classes in different parts of the Kingdom are now affiliated to the Institute, and some of them are already developing into efficient technical schools. The assistance which the Institute is enabled to afford to these classes is restricted by want of means; but there can be no doubt that far larger opportunities of obtaining evening instruction in the application of the different branches of science to industry are afforded to the artisans of London now than was the case even four or five years ago.

Large additions have been made to the equipment of the Central Institution at South Kensington. The engineering laboratory and the extensive chemical and physical laboratories are organised, and the systematic instruction of students has commenced. Scholarships of the value of 30*l*. a year, tenable for three years, have been offered to, and accepted by, the Governors of a number of public and other schools. These scholarships are to be awarded by the head-master (not necessarily on the result of a competitive examination) to any pupil who is competent to pass the entrance examination of the Central Institution.

The City and Guilds Institute is the outcome of the perception of the necessity for technical education, in the interests of industry, by the wealthiest city and the wealthiest guilds in the world; it may, therefore, seem singular that the chief obstacle to the proper development of the important schools which it has founded is poverty. Such, however, I understand to be the case. The Central Institution requires an assured income of at least 15,000*l.* a year if it is to work properly; but the joint resources of the City and Guilds of London, at present, appear to be able to afford it only a precarious, annually-voted, subsidy of 9000*l.* a year—far less, that is to say, than the private income of scores of individual Londoners. In Germany, a similar institution would demand and receive 20,000*l.* a year as a matter of course; but Englishmen are famous for that which a perplexed Chancellor of the Exchequer (I think it was) once called their "ignorant impatience of taxation," and there is no occasion on which they so readily display that form of impatience as when they are asked for money for education, especially scientific education. I am bound to add, however, that my experience on the Council and Committees of the Institute has left no doubt on my mind that my colleagues have every desire to carry out the work they have commenced thoroughly; and that the money difficulty will disappear along with certain other difficulties which, I am disposed to think, need never have arisen.

Such are the chief matters of business, if I may so call them, which it is proper for me, in my Presidential capacity, to bring before the Society. But it has been not unusual, of late years, for the occupant of the Chair to offer some observations of a wider bearing for the consideration of the Society; and I am the more tempted to trespass upon your patience for this purpose, as it is the last occasion on which I shall be able to use, or abuse, the President's privileges.

So far as my own observations, with respect to some parts of the field of natural knowledge, and common report, with respect to others, enable me to form an opinion, the past year exhibits no slackening in the accelerated speed with which the physical sciences have been growing, alike in extent and in depth, during several decades. We are now so accustomed to this "unhasting but unresting" march of physical investigation; it has become so much a part of the customary course of events, that, with every day, I might almost say with every hour, something should be added to our store of information respecting the constitution of nature, some new insight into the order of the cosmos should be gained, that you would probably listen with incredulity to any account of the year's work which could not be summed up in this commonplace of Presidential addresses.

Nor shall I be chargeable with innovation if I add that there is no reason to suspect that the future will bring with it any retardation in the advance of science. The adverse influences, which, in the middle ages, arrested the work commenced by the older Greek philosophers, are so much weakened that they no longer offer any serious obstacle to the growth of natural knowledge; while they are powerless to prevent the extension of scientific methods of inquiry and the application of scientific conceptions to all the problems with which the human mind is confronted. If any prophecy is safe of fulfilment, it is that, in the twentieth century, the influence of these methods and conceptions will be incomparably greater than it is now; and that the inter-penetration of science with the common affairs of life, which is so marked a feature of our time, will be immeasurably closer. For good or for evil, we have passed into a new epoch of human history—the age of science.

It may seem superfluous that I should adduce evidence in support of propositions which must have so much of the nature of truisms to you who are sharers in the work of science and daily witnesses of the effects of its productive energy. But the proverbial tendency of familiarity to be incompatible with due respect is noticeable even in our appreciation of the most important truths, and our strongest convictions need furbishing up now and then, if they are to retain their proper influence. I certainly cannot accuse myself of ever having consciously entertained a low estimate of the past work or the future progress of science; but, a few months ago, enforced leisure and the attainment of an age when retrospection tends to become a habit, not to say a foible, led me to look at the facts anew; and I must confess that the spectacle of the marvellous development of science, alike in theory and practice, within my own life-time, appeared to me to justify a faith, even more robust than mine, in its future greatness.

For, if I do not greatly err, the greater part of the vast body of knowledge which constitutes the modern sciences of physics, chemistry, biology, and geology, has been acquired, and the widest generalisations therefrom have been deduced, within the last sixty years; and, furthermore, the majority of those applications of scientific knowledge to practical ends, which have brought about the most striking differences between our present civilisation and that of antiquity, have been made within that period of time.

To begin with the latter point—the practical achievements of science. The first railway for locomotives, which was constructed between Stockton and Darlington, was opened in September, 1825, so that I have the doubtful advantage of about four months' seniority over the ancestral representative of the vast reticulated fetching and carrying organism which now extends its meshes over the civilised world. I confess it fills me with astonishment to think that the time when no man could travel faster than horses could transport him, when our means of locomotion were no better than those of Achilles or of Ramses Maimun, lies within my memory. The electric telegraph, as a thing for practical use, is far my junior. So are arms of precision, unless the old rifle be regarded as such. Again, the application to hygiene, and to the medical and surgical treatment of men and animals, of our knowledge of the phenomena of parasitism, and the very discovery of the true order of these phenomena, is a long way within the compass of my personal knowledge.

It is unnecessary for me to enumerate more than these four of the many rich gifts made by science to mankind during the last sixty years. Arresting the survey here, I would ask if there is any corresponding period in previous history which can take credit for so many momentous applications of scientific knowledge to the wants of mankind? Depreciators of the value of natural knowledge are wont to speak somewhat scornfully of these and such-like benefactions as mere additions to material welfare. I must own to the weakness of believing that material welfare is highly desirable in itself, and I have yet to meet with the man who prefers material illfare. But even if this should be, as some may say, painful evidence of the materialistic tendencies incidental to scientific pursuits, it is surely possible, without much ingenuity, or any prejudice in favour of one or other view of the mutual relations of material and spiritual phenomena, to show that each of these four applications of science has exerted a prodigious influence on the moral, social, and political relations of mankind, and that such influence can only increase as time goes on.

If the senseless antipathies, born of isolation, which formerly converted neighbours, whether they belonged to adjacent families or to adjacent nations, into natural enemies, are dying away, improved means of communication deserve the chief credit of the change; if war becomes less frequent, it will be chiefly because its horrors are being intensified beyond bearing by the close interdependence and community of interest thus established between nations, no less than by the improvement of the means of destruction by scientific invention. Arms of precision have taken the mastery of the world out of the hands of brute force and given it into those of industry and intelligence. If railways and electric telegraphs have rendered it unnecessary that modern empires should fall to pieces by their own weight as ancient empires did, arms of precision have provided against the possibility of their being swept away by barbarous invasions. Health means not merely wealth, not merely bodily welfare, but intellectual and moral soundness; and I doubt if, since the time of the father of medicine, any discovery has contributed so much to the promotion of health and the cure of disease as that of the part played by fungoid parasites in the animal economy, and that of the means of checking them, even though, as yet, unfortunately it be only in a few cases.

But though these practical results of scientific work, during only two generations, are calculated to impress the imagination, the Fellows of this Society know well enough that they are of vastly less real importance than the additions which have been made to fact and theory and serviceable hypothesis in the region of pure science. But it is exactly in these respects that the record of the past half century is so exceptionally brilliant. It is sometimes said that our time is a day of small things—in science it has been a day of the greatest things, for, within this time, falls the establishment, on a safe basis, of the greatest of all the generalisations of science, the doctrines of the Conservation of Energy and of Evolution.

As for work of less wide scope, I speak in the hearing of those who can correct me if I am wrong, when I say that the larger moiety of our present knowledge of light, heat, electricity, and magnetism, has been acquired within the time to which I refer; and that our present chemistry has been in great part created, while the whole science has been remodelled from foundation to roof. It may be natural that progress should appear most striking to me among those sciences to which my own attention has been directed, but I do not think this will wholly account for the apparent advance "by leaps and bounds" of the biological sciences within my recollection. The cell theory was the latest novelty when I began to work with the microscope, and I have watched the building of the whole vast fabric of histology; I can say almost as much of embryology, since Von Baer's great work was published in 1828. Our knowledge of the morphology of the lower animals and plants, and a great deal of that of the higher forms, has very largely been obtained in my time; while physiology has been put upon a totally new foundation, and, as it were reconstructed, by the thorough application of the experimental method to the study of the phenomena of life, and by the accurate determination of the purely physical and chemical components of these phenomena. The exact nature of the processes of sexual and non-sexual reproduction has been brought to light. Our knowledge of geographical and geological distribution, and of the extinct forms of life, has been increased a hundredfold. As for the progress of geological science, what more need be said than that the first volume of Lyell's "Principles" bears the date of 1830?

This brief enumeration of the salient achievements of science in the course of the last sixty years is sufficient not only to justify what I have said respecting their absolute value, but to show how much it excels, both in quantity and quality, the work produced in any corresponding period since the revival of science. It suggests, as I have said, that science is advancing and will continue to advance with accelerated velocity.

It seems to me, in fact, not only that this is so, but that there are obvious reasons why it must be so. In the first place, the interdependence of all the phenomena of nature is such that a seemingly unimportant discovery in one field of investigation may react in the most wonderful manner upon those which are most widely remote from it. The investments of science bear compound interest. Who could have imagined that a curious inquiry into the relations of electricity with magnetism would lead to the construction of the most delicate instruments for investigating the phenomena of heat; to means of measuring not only the smallest intervals of time, but the greatest depths of the ocean; to methods of exploring some of the most hidden secrets of life? What an enormous revolution would be made in biology, if physics or chemistry could supply the physiologist with a means of making out the molecular structure of living tissues comparable to that which the spectroscope affords to the inquirer into the nature of the heavenly bodies. At the present moment the constituents of our own bodies are more remote from our ken than those of Sirius, in this respect. In the next place, the vast practical importance of the applications of scientific knowledge has created a growing demand for technical education based upon science. If this is to be effective, it means the extension of scientific teaching to all classes of the community, and the encouragement and assistance of those who are fit for the work of scientific investigation to adopt that calling. Lastly, the attraction of the purely intellectual aspects of science and the rapid growth of a sense of the necessity of some knowledge of the phenomena of nature, and some discipline in scientific methods of inquiry, to every one who aspires to take part in, or even to understand, the tendencies of modern thought, have conferred a new status upon science in the seats of learning, no less than in public estimation.

Once more reverting to reminiscence, the present state of scientific education surely presents a marvellous and a most satisfactory contrast to the time, well within my memory, when no systematic practical instruction in any branch of experimental or observational science, except anatomy, was to be had in this country; and when there was no such thing as a physical, chemical, biological, or geological laboratory open to the students of any University, or to the pupils of any school, in the three kingdoms. Nor was there any University which recognised science as a faculty, nor a school, public or private, in which scientific instruction was represented by much more than the occasional visit of a vagrant orrery.

At the present moment, any one who desires to obtain a thoroughly scientific training has a choice among a dozen institutions; and elementary scientific instruction is, so to speak, brought to the doors of the poorer classes. If the rich are debarred from like advantages, it is their own affair; but even the most careful public school education does not now wholly exclude the knowledge that there is such a thing as science from the mind of a young English gentleman. If science is not allowed a fair share of the children's bread, it is at any rate permitted to pick up the crumbs which fall from the time-table, and that is a great deal more than I once hoped to see in my life-time.

I have followed precedent in leading you to the point at which it might be fair, as it certainly would be customary, to end by congratulating you, as Fellows of the Royal Society, on the past progress and the future prospects of the work which, for two centuries, it has been the aim of the Society to forward. But it will perhaps be more profitable to consider that which remains to be done for the advancement of science, than to "rest and be thankful" in the contemplation of that which has been done.

In all human affairs the irony of fate plays a part, and in the midst of our greatest satisfactions, "surgit amari aliquid." I should have been disposed to account for the particular drop of bitterness to which I am about to refer, by the sexagenarian state of mind, where it not that I find the same complaint in the mouths of the young and vigorous. Of late years it has struck me, with constantly increasing force, that those who have toiled for the advancement of science are in a fair way of being overwhelmed by the realisation of their wishes. We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. If he were to attempt to do so, his mental faculties would be crushed by the multitudes of journals and of voluminous monographs which a too fertile press casts upon him. This was not the case in my young days. A diligent reader might then keep fairly informed of all that was going on, without robbing himself of leisure for original work, and without demoralising his faculties by the accumulation of unassimilated information. It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrower and narrower specialist, as time goes on.

I am happy to say that I do not think any such catastrophe a necessary consequence of the growth of science; but I do think it is a tendency to be feared, and an evil to be most carefully provided against. The man who works away at one corner of nature, shutting his eyes to all the rest, diminishes his chances of seeing what is to be seen in that corner; for, as I need hardly remind my present hearers, that which the investigator perceives depends much more on that which lies behind his sense-organs than on the object in front of them.

It appears to me that the only defence against this tendency to the degeneration of scientific workers, lies in the organisation and extension of scientific education, in such a manner as to secure breadth of culture without superficiality; and, on the other hand, depth and precision of knowledge without narrowness.

I think it is quite possible to meet these requirements. There is no reason, in the nature of things, why the student who is destined for a scientific career should not, in the first place, go through a course of instruction such as would insure him a real, that is to say, a practical acquaintance with the elements of each of the great divisions of mathematical and physical science; nor why this instruction in what (if I may borrow a phrase from medicine) I may call the institutes of science, should not be followed up by more special instruction, covering the whole field of that particular division in which the student eventually proposes to become a specialist. I say not only that there is no reason why this should not be done, but, on the ground of practical experience, I venture to add that there is no difficulty in doing it. Some thirty years ago, my colleagues and I framed a scheme of instruction on the lines just indicated, for the students of the institution which has grown into what is now known as the Normal School of Science and Royal School of Mines. We have found no obstacles in the way of carrying the scheme into practice except such as arise, partly, from the limitations of time forced upon us from without; and, partly, from the extremely defective character of ordinary education. With respect to the first difficulty, we ought, in my judgment, to bestow at least four, or better five, years on the work which has, at present, to be got through in three. And, as regards the second difficulty, we are hampered not only by the ignorance of even the rudiments of physical science, on the part of the students who come to us from ordinary schools, and by their very poor mathematical acquirements, but by the miserable character of the so-called literary training which they have undergone.

Nothing would help the man of science of the future to rise to the level of his great enterprise more effectually than certain modifications, on the one hand, of primary and secondary school education, and, on the other, of the conditions which are attached by the Universities to the attainment of their degrees and their rewards. As I ventured to remark some years ago, we want a most favoured nation clause inserted in our treaty with educators. We have a right to claim that science shall be put upon the same footing as any other great subject of instruction, that it shall have an equal share in the schools, an equal share in the recognised qualification for degrees, and in University honours and rewards. It must be recognised that science, as intellectual discipline, is at least as valuable, and, as knowledge, is at least as important, as literature, and that the scientific student must no longer be handicapped by a linguistic (I will not call it literary) burden, the equivalent of which is not imposed upon his classical compeer.

Let me repeat that I say this, not as a depreciator of literature, but in the interests of literature. The reason why our young people are so often scandalously and lamentably deficient in literary knowledge, and still more in the feeling and the desire for literary excellence, lies in the fact that they have been withheld from a true literary training by the pretence of it, which too often passes under the name of classical instruction. Nothing is of more importance to the man of science than that he should appreciate the value of style, and the literary work of the school would be of infinite value to him if it taught him this one thing. But I do not believe that this is to be done by what is called forming one's self on classical models, or that the advice to give one's days and nights to the study of any great writer, is of much value. "Le style est l'homme même," as a man of science who was a master of style has profoundly said; and aping somebody else does not help one to express one's self. A good style is the vivid expression of clear thinking, and it can be attained only by those who will take infinite pains, in the first place, to purge their own minds of ignorance and half knowledge, and, in the second, to clothe their thoughts in the words which will most fitly convey them to the minds of others. I can conceive no greater help to our scientific students than that they should bring to their work the habit of mind which is implied in the power to write their own language in a good style. But this is exactly what our present so-called literary education so often fails to confer, even on those who have enjoyed its fullest advantages; while the ordinary schoolboy has rarely been even made aware that its attainment is a thing to be desired.

I venture to lay these last observations before you, because we have heard a good deal lately of schemes for the remodelling of the University of London, which has done so much, through its Faculties of Science and Medicine, to promote scientific instruction. As a member of the Senate of the University I am necessarily greatly interested in such projects, and I greatly regret that I have been unable to take part in the recent action concerning them. This is not the time or the place for the discussion of any of these proposals, but many of my hearers must be as warmly interested in them as I am myself, and it may not be out of place to submit two questions for their serious consideration.

In the interests of science, will any change be satisfactory which does not lighten the linguistic burden at present imposed on students of science and of medicine by the matriculation examination?

And again, in the interests of science, will any change be satisfactory which does not convert the examining University into a teaching University? And, by that last term, I do not mean a mere co-operative society of teacher-examiners, but a corporation which shall embrace a professoriate charged with the exposition and the advancement of the higher forms of knowledge in all its branches.

The future both of pure science and of medicine in this country is, I think, greatly interested in the answer which Fellows of this Society, after due meditation, may be disposed to give to these questions.

I have to announce an unusually large number of changes in the staff of the Society.

Last December we regretted to receive the resignation of Mr. Walter White, so long our Assistant Secretary, whose faithful and efficient services, continued for more than forty years, are well known to all the Fellows of the Society. The minutes of the Council record our appreciation of Mr. White's services, and our endeavour to give as substantial a form as possible to our hearty recognition of his deserts. The vacancy thus caused has been filled up by the appointment of Mr. Herbert Rix, whose work since he has held the office of clerk has been such as to justify the confidence of the officers, not only that the functions hitherto discharged by the Assistant Secretary will be as well performed as heretofore; but that, if the interest of the Society should demand it, we may throw still more important duties upon him. I receive the most favourable reports of the efficiency of Mr. James, who has been appointed to the office of clerk in place of Mr. Rix.

Notwithstanding my release from all serious work, my health remained so very indifferent for some months after my return to England that I felt it my duty to the Society to bring the question of my resignation of the Presidency, on the present Anniversary, before the Council which met on May 20. My colleagues were kind enough to wish that my final decision should be deferred, and I need hardly say how willing I should have been to retain my honourable office if I could have done so with due regard to the interests of the Society, and, perhaps I may add, of self-preservation.

I am happy to say that I have good reason to believe that, with prolonged rest—by which I do not mean idleness, but release from distraction and complete freedom from those lethal agencies which are commonly known as the pleasures of society—I may yet regain so much strength as is compatible with advancing years. But, in order to do so, I must, for a long time yet, be content to lead a more or less anchoritic life. Now it is not fitting that your President should be a hermit, and it becomes me, who have received so much kindness and consideration from the Society, to be particularly careful that no sense of personal gratification should delude me into holding the office of its representative one moment after reason and conscience have pointed out my incapacity to discharge the serious duties which devolve upon the President, with some approach to efficiency.

I beg leave, therefore, with much gratitude for the crowning honour of my life which you have conferred upon me, to be permitted to vacate the chair of the Society as soon as the business of this meeting is at an end.

As I am of opinion that it is very undesirable that the President should even seem to wish to exert any influence, direct or indirect, on the action of the Fellows assembled in General Meeting, I am silent respecting the proposals embodied in the new list of the officers of the Society which my colleagues and I have unanimously agreed to submit for your consideration.

The President then proceeded to the presentation of the Medals:—

The Copley Medal is awarded to Prof. August Kekulé of Bonn, whose researches in organic chemistry, extended over the last five-and-thirty years, have been fruitful of results of high importance in chemical science. The great work of Prof. Kekulé's life, that which has raised him to the highest rank among the investigators of the day, is his general theory of the constitution of carbon compounds, in which the now universally accepted conception of the constitution of those compounds was first clearly and definitely stated.

A development of the fundamental theory led Kekulé to the discovery of the constitution of an exceedingly numerous and very complex class of compounds, which he has named the aromatic compounds, and his theory of the constitution of the aromatic compounds has suggested and guided innumerable investigations. The marvellous success obtained by many of his followers and pupils in building up artificially complex substances which had defied the efforts of all previous investigators, affords tangible evidence that Kekulé's labours have given us a deeper insight into the order of nature.

One of the Royal Medals is awarded to Prof. Hughes, F.R.S., for a series of experimental investigations in electricity and magnetism, which are remarkable alike for ingenuity of contrivance, for the simplicity of the apparatus employed, for the delicacy of the indications afforded, and for the wide applicability of the instruments invented to researches other than those for which they were originally designed.

The microphone, the induction balance, and the sonometer, are instruments by which inconceivably minute electrical and magnetic disturbances not only make themselves loudly audible, but may be definitely measured; and their application has opened up new lines of inquiry.

The other Royal Medal is awarded to Prof. E. Ray Lankester, F.R.S., for his labours, now extending over more than twenty years, in the field of animal morphology (especially invertebrate anatomy and embryology) and of palæontology.

Prof. Lankester has been active in many directions, and has everywhere left his mark, not only as an energetic teacher and accurate worker and a philosophical thinker; but as one who, in times when the example is more than ever valuable, has always been careful to remember that speculation should be the servant and not the master of the biologist.

The Davy Medal is awarded to Prof. Stas of Brussels.

Prof. Stas's great research, for which it is proposed that the Davy Medal be awarded to him, is that on atomic weights. There are probably no researches in chemistry, the results of which appeal so little to the imagination, and which are so little applauded, as those on atomic weights, yet for difficulty and importance they are hardly surpassed by any. The determination of these fundamental constants of chemistry has engaged the attention of many of the leading chemists, and before the time of M. Stas's experiments, an immense amount of careful labour had been bestowed on finding methods for the more accurate and complete purification of the compounds employed for the purpose.

The indefatigable and conscientious care which M. Stas has devoted to the re-determination of a certain number of the most important atomic weights, and the marvellous skill with which he has overcome the various difficulties which successively presented themselves, render his memoir on the subject one of the most remarkable and valuable of chemical monographs.

I regret to say that the state of M. Stas's health has not permitted him to be with us to-day, but the representative of his Sovereign, the King of the Belgians, in this country, has kindly consented to receive the medal for him.

M. le Baron Solvyns, I request your Excellency to be so good as to receive the medal awarded to M. Stas; and to assure him of the pleasure which it gives the Royal Society to show their sense of his high merits, by asking his acceptance of this memorial of his illustrious predecessor, Humphry Davy.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In the Examination for Chemistry and Physics for 1st M.B. last June, an unusually large proportion of candidates were rejected. At the request of the Special Board for Medicine, the Examiners, Messrs. Pattison Muir, A. Scott, A. Schuster, and W. N. Shaw, have stated their opinion that the candidates showed very little mental training; they had almost no power of expressing clearly what they knew, whether facts, or conclusions from facts. Prof. Michael Foster has written a letter to Prof. Paget on this subject, partly derived from his recent experience in examining in Physiology in the 2nd M.B., and deploring the condition in which men enter the University, not only ignorant of Chemistry and Physics, but unprepared by any adequate discipline to receive the truths of experimental science. He believes no proper reform can come until the University makes such a change in the Previous or Preliminary Examination as shall permit a lad at school to study Chemistry and Physics, and give him time to do so by relieving him of some other subjects. The last clause is most important, and we are glad Prof. Foster emphasised it. The University requirements in the Preliminary Examinations determine the whole current of school work, and to move them in the direction of requiring, or at any rate permitting, Chemistry and Physics to be adequately taught at schools, should be a foremost object of scientific educationists.

Mr. R. G. Moulton, one of the most experienced lecturers on the University extension scheme, writes to advocate the establishing of a general organisation on a permanent basis. He points out that the best lecturers are lost when most valuable, owing to the lack of an assured position; also that the local committees need to be brought into connection with each other. A body also is needed which could seek and receive endowments. During the last ten years 50,000*l.* has been spent in the scheme, and 60,000 students have attended full courses of lectures.

The following Colleges offer Natural Science Scholarships or Exhibitions for open competition during the present and next month; the respective dates of examination being affixed:—Gonville and Caius, December 8; King's College, December 10; Jesus College, January 4; Christ's, Emmanuel, and Sidney-Sussex Colleges in common, January 5; St. John's College, December 10; Trinity College, December 10.

SCIENTIFIC SERIALS

Rivista Scientifico-Industriale, October 15.—On lateral atmospheric refraction, by Dr. G. Andries.—Transport and distribution of electricity by means of induced transformers: system of Zipernowsky, Deri, and Blathy, by Emilio Piazzolo.—On electric contrivances for illuminating fluids in scientific laboratories (four illustrations), by the editor.—On the microscopic organisms present in drinking-water: their life in waters charged with carbonic acid, by Dr. T. Leone.

THE *Journal of the Royal Microscopical Society*, vol. v. ser. ii part 5, October, contains:—On new British micro-fungi, by G. Massee (plate 13).—On erosion of the surface of glass when exposed to the joint action of carbonate of lime and colloids, by Dr. W. M. Ord.—On a septic microbe from a high altitude, by G. F. Dowdeswell.—On the use of the avicularian mandible in the determination of the chilostomatous Polyzoa, by Arthur W. Waters (plate 14).—The usual summary of current researches.

THE *American Naturalist* for October contains:—Mythic dry-paintings of the Novayos (illustrated), by W. Matthews.—The relations of mind and matter, by C. Morris.—A biography of the halibut, by G. B. Goode.—Traces of prehistoric man of the Watash, by John T. Campbell.—Editor's Table, Recent Literature, and General Notes.

THE *Victoria Royal Society Transactions*, vol. xxi. issued June 30, among other papers contains the following:—Evidences of a Glacial epoch in Victoria during post-Miocene times, by G. S. Griffiths.—The Phanerogama of the Mitta-Mitta Source Basin, II., by James Stirling.—Shingle on the east coasts of New Zealand, by W. W. Culcheth, M.Inst.C.E.—New or little-known Polyzoa, Part VII. (Plates 1 to 3), Part VIII. (Plates 1 to 5, by P. H. MacGillivray, M.A.—On the reproduction of the Ornithorhynchus, by P. H. MacGillivray, M.A.—On the Diabase rocks of the Buchan district; supplementary notes by A. W. Howett.—The meteorology of the Australian Alps, by James Stirling.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 19.—Prof. Moseley, F.R.S., in the chair.—Mr. A. D. Michael exhibited and described the remarkable nymphal stage of *Tegeocranus cepheiformis*, a species of the Oribatidæ, which he lately discovered for the first time in England. He has furthermore succeeded in tracing the whole life-history of this animal. The creature in its nymphal stage is exceedingly strange and beautiful. It carries on its back as concentric shields the dorsal portions of all its cast-skins, and these are bordered by projections each bearing a rose-leaf-like cuticular process of transparent membrane with chitinous nervures. The drawing of the nymph was first sent to Mr. Michael, two years ago, by Herr Pappe, of Bremen.—Mr. C. Stewart demonstrated, under the microscope, the stridulating apparatus of a species of *Sphærotherium*, differing in some respects from that described by Mr. Bourne (*infra*).—Dr. J. Murie exhibited and made remarks on the caudal end of the spine of a haddock with an arched deformity, recalling what is recorded of the so-called hump-backed cod (*Morrhua macrocephala*).—Mr. G. J. Fookes called attention to some twin-apples, of teratological interest. These were grown at Shepherd's Bush, upon a tree eighty years old, which last year was nearly barren, but this year produced abundantly, many of the fruits being good examples of syncarpy.—Prof. P. M. Duncan read a paper on the perignathic girdle of the Echinoidea. The author maintained that as the structures which give attachment to the muscles that protrude and retract the jaws of the Echinoidea (which are parts of the test surrounding the peristome within) are not homologous in all the families of the group, therefore it is unadvisable to retain the old name of "auricles." He suggests to substitute the term "perignathic girdle." The girdle consists of processes usually united above (though occasionally disconnected), and of "ridges" which connect the processes on the side remote from the ambulacra. The ridges are modifications of the inter-radial plates, the processes developments from the ambulacral plates. In the Cidaridæ, the muscular attachments are all on disconnected ridges, and there are no processes. In the Temnopleuridæ, Echinidæ, Echinometridæ, and Diadematidæ, the retractor muscles are attached to "processes" which are growths of the poriferous portions of the ambulacral plates; and the protractor muscles and ligament of the radiales are attached to the ridge which is developed on the inter-radial plates, and is united by suture to the base of the "process." In the Clypeastridæ there are disconnected growths which carry the jaws and have slight muscular attachments. In *Clypeaster* there are ten processes, each arising from an ambulacral plate; and there are no inter-radial structures like ridges. In *Laganum* there are five growths, each arising from a first inter-radial plate; hence these are the homologues of ridges. The Clypeastridæ may thus be divided into two groups, on account of the presence of processes in one, and of the homologues of ridges in the other.—Prof. Moseley communicated a paper on the anatomy of *Sphærotherium* by Mr. G. C. Bourne. The author mentioned that while the general exterior features and specific distinctions of the genus had been amply discussed, the internal structures had hitherto received scant attention. Among other anatomical peculiarities he describes a well-defined stridulating organ in the male. This consists of a prominent bolster-shaped swelling on the postero-external edge of the second joint of the second pair of copulatory appendages. The swelling occupies the entire margin of the joint, and shows a number of chitinous cross ridges and furrows. On the opposite interior surface of the last tergite are chitinous points. The former rasp-like organ of the second accessory appendages when rubbed rapidly against the latter produce a shrill note resembling that emitted by the house cricket. A true auditory organ exists in the antennary fossa beneath the eye. The tracheal system is unlike the majority of that of the Diplopoda, rather resembling that of Chilopoda and Insecta, though differing in the branched spiral filament not taking origin directly from the stigmata themselves. It appears that the tracheæ of *Sphærotherium* are a transition from those of the Julus type to those of the Scolopendra type. It would thus seem that the character of the tracheæ, the curved alimentary tract, the numerous chitinous pieces composing each segment, and the presence of a special hearing organ on the head, mark off the family Glomeridæ (to which *Sphærotherium* belongs) very sharply from the other families of the Diplopoda.—Prof. Moseley afterwards read extracts of letters from Mr. G. C. Bourne, who is now in the Chagos Archipelago, and from Mr. Sydney Hickson in the Celebes (Oxford graduates), and now investigating the natural history of the regions in question.—There followed a paper, contributions to South African botany, Orchideæ, part 2, by Mr. H. Bolus, with additional notes by Mr. N. E. Brown.

PARIS

Academy of Sciences, November 23.—M. Jurien de la Gravière, President, in the chair.—Observations of the minor planets made with the great meridian of the Paris Observatory during the third quarter of the year 1885, communicated by M. Mouchez.—Researches on the functions of Wrisberg's nerve, by M. Vulpian.—On a new theory of algebraic forms, by M. Sylvester.—On the sulphate of sparteine as a dynamic medicine and cure for the irregular action of the heart, by M. Germain Sée. This alkaloid (C_{15} or $C_{13}, H_{26}N_2$), obtained in 1850 by Stenhouse from *Spartium scoparium*, is found to be a sovereign remedy for feeble, irregular, and abnormal pulsation. It also instantaneously restores enfeebled circulation, while preserving or increasing muscular vigour.—Action of lime (milk of lime) on the vine attacked by mildew, by the Duchess de Fitz-James. The author regards this preparation as the most practical, efficacious, and economical for vines attacked by mildew in the south of France.—Note on Lagrange's interpolating formula as presented by M. Hermite in *Crelle's Journal*, vol. lxxxiv., by M. Bendixson.—Note on Kœnig's theorem regarding the living force animating a material system at a given moment, by M. Ph. Gilbert.—Application of the cryoscopic method to the determination of molecular weights, by M. F. M. Raoult. It is shown that by this method the molecular weight of any substance may be determined with great certainty, provided such substance, or one of its compounds, or one of its derivatives obtained by substitution, be soluble either in water, acetic acid, or benzene. It presents the further advantage that the results thus obtained are susceptible of verification in several ways.—Researches on hypophosphoric acid ($PHO_4,2HO$ or $PH_2O_8,4HO$), by M. A. Joly.—Heat of combustion of some substances of the fat series, by M. Louguinine. The substances here studied with a view to determining their heat of combustion are: paraldehyde; normal propionic acid and anhydride; normal propionic acid purified and analysed by the author; aldol.—Note on a new method of chloridation, by MM. Albert Colson and Henri Gautier. Two points are established: (1) that the perchloride of phosphorus allows the introduction of a determined quantity of chlorine into the homologues of benzene; (2) that the chlorine liberated by the perchloride of phosphorus acts on the benzenic hydrogen only after being substituted for the hydrogen of the lateral series. —On the presence of methylic alcohol in the products derived from the distillation of plants with water, by M. Maquenne.—On the gutta-percha of *Bassia* (Butyrospermum) *parkii*, G. Don, and its chemical composition, by MM. Ed. Heckel and Fr. Schlagdenhauffen. The gutta-percha obtained from this plant is shown to be in every respect comparable to, and in structure almost identical with, that yielded by the better-known *Isonandra gutta*, Hooker.—On the pretended circulation in the ganglionar cells of animal organisms, by M. W. Vignal.—Remarks on the acicular apparatus of some Echinidæ of the Chalk and Tertiary epochs, by M. Munier-Chalmas.—Note on a meteor observed in Paris on November 18, by M. Stanislas Meunier.—On the shower of meteors which may, perhaps, accompany the transit of the earth through the descending nucleus of Biela's comet on November 27, by M. Zenker.—A second reply to M. Charpentier respecting the functions of the several elements of the retina producing the sensations of light, colour, and form, by M. H. Parinaud.—Observations on MM. Martel and de Launay's note on certain fragments of human crania and a fragment of pottery found in the cave of Nabriguas, and said to be contemporary with *Ursus spelæus*, by M. Emile Cartailhac. The author, who has several times visited this cave, is satisfied that it has been exposed to frequent inundations, and that, consequently, the ground has been disturbed even since the beginning of the Quaternary period. Hence, although man was certainly contemporary with *Ursus spelæus* in the west of Europe, he did not live in association with that animal, but probably took possession of the Nabriguas and other similar caves after its extinction in Neolithic times. The potsherd in question has been subjected to the action of fire, and is evidently of comparatively recent date, washed into the cave by the flood waters.

CONTENTS

THURSDAY, DECEMBER 10, 1885

THE "ENCYCLOPÆDIA BRITANNICA"

Encyclopædia Britannica. Ninth Edition. Vols. XVIII. and XIX. (Edinburgh: A. and C. Black, 1885.)

THESE two volumes are almost entirely occupied with letter P, and yet it is not finished. Though there are no articles of the tremendous length of some in the earlier volumes, still there are many of more than the average length and importance. In Vol. XVIII. we have such articles as Ornithology, by Prof. Newton; Parallax, by Mr. David Gill; Pacific Ocean, by Mr. John Murray; and Phosphorescence, by Prof. Pritchard. In Vol. XIX. again we have a valuable fragment on the Physical Sciences, by the late Clerk Maxwell; Pisciculture, by Mr. Browne Goode; Planarians, by Prof. L. V. Graaf; Polar Regions, by Mr. C. R. Markham; Physiology, by Prof. M. Foster, Prof. McKendrick, and Mr. S. H. Vines; and Pianoforte, by Mr. A. J. Hipkins. We have only space to notice at length the articles on Ornithology, Physiology, and Pianoforte.

Prof. Alfred Newton's article "Ornithology" stamps him as the first ornithological critic of the day, and his treatment of this most difficult subject is, as far as it goes, a model of scientific arrangement and elegant diction. He traces the history of ornithology from the very earliest times by a record of successive authors and their work, and then discusses the families of birds with a dissertation on the merits of the various systems which have been lately proposed, but it is in the record of recent ornithological work that we find the most conspicuous failure of Prof. Newton to do justice to his contemporaries. Whether want of space compelled the author to abridge this part of the subject we know not, but if the article "Ornithology" is supposed to be a history of the science down to the year 1884, the student of the future will greatly wonder at the omissions, not knowing how to attribute them to a critic whose account of the early history of the subject is so wonderfully complete and minute. It was doubtless a mere oversight on the part of the author to have attributed the completion of Gould's "Supplement to the Humming-birds" to Mr. Salvin instead of to Mr. Sharpe, but we should have expected to find some little account of the publications of the last-named ornithologist, whose name is not mentioned in connection with the "Catalogue of Birds in the British Museum," with which it is likely to be remembered in the history of ornithology, more than with the foundation of Dresser's "Birds of Europe," and with the second edition of Layard's "Birds of South Africa," with which Prof. Newton associates it. In the latter case Mr. Sharpe must be held to have done his work badly, as, despite his incorporation of all the excellent work of Mr. J. H. Gurney in his edition of "Layard," the latter ornithologist has a "knowledge of South African ornithology perhaps greater than that of any one else." No classification of birds as yet proposed satisfies Prof. Newton, any more than it does any other ornithologist; but Mr. Sharpe's publication of Sundevall's scheme of classification will *not* be considered "so much waste of time" by those who recognise that, with all its faults, it contains, like all well-matured schemes, many points of excellence and hints on classification in advance of his predecessors. The same must be said of Dr. Sclater's recent scheme, and also of Prof. Newton's own critical remarks in the present article. All are contributions towards a final natural arrangement of the class "*Aves*," if such indeed will ever be compassed. The arrangement of the British Museum "Catalogue" is well known to be faulty, but it is only by the complete description of every genus and its component species that a correct idea of their relations can ultimately be entertained, and to entirely ignore the new volumes of the "Catalogue" is at least matter for wonderment, seeing that already 4116 species have been described in its pages with their full synonymy up to date, while 196 species have been figured. Similarly Prof. Newton, in his enumeration of recent works on British ornithology, omits to mention Mr. Seebohm's name altogether, though the "History of British Birds" was far advanced towards completion in 1884. We might also complain of the scant justice done to Mr. Harting, whose popular work on the "Birds of Middlesex" was the forerunner, if not the exact model, of many of those books on county ornithology, space to mention which is found by Prof. Newton. No doubt some future historian will carry on the record of ornithological prowess from the point where it is left by Prof. Newton, but one thing is certain, that every subsequent writer will be indebted to the author for his facts concerning the early history of ornithology, which we believe to be one of the most complete and exhaustive records ever published.

The article "Physiology" in the last-issued volume is a threefold one of considerable length. Dr. Vines gives us an extended treatise on vegetable physiology, whilst Prof. McKendrick discusses in detail certain aspects of the physiology of the nervous system. Without detracting from the merit of these two pieces of work, which are full of valuable information, we may say at once that the section of the article written by Prof. Michael Foster, which precedes these, is that which will command most attention and indeed should be read by every student of science as well as by the intelligent layman who wishes to know the past, present, and future of the branch of science which is, perhaps more than any other, destined to influence the welfare of humanity. Prof. Foster's essay is in fact a very remarkable one; admirable in style, vigorous and lucid, it gives the reader the impression, which is well founded, that he is being shown the inner history of the growth and development of a great science by one who has the clear vision and unerring judgment of a master of his subject. Hereafter Prof. Foster's article will retain permanent value as the best exposition of the way in which the problems of physiology were regarded, both retrospectively and with a view to future progress, in the latter quarter of the nineteenth century.

Prof. Foster commences by defining physiology as "the study of the actions of living beings on their surroundings and correlatively of the action of the surroundings on the living being," whilst he points out that at an earlier period physiology comprised morphology and corresponded to what is now called biology.

Then follows a sketch of these "actions of a living being." They are brought under three heads:—(1)

Movements; dependent upon the contractions of muscles and the existence of mechanical contrivances connected therewith. (2) *Activity of the Nervous System;* in controlling in various ways and in relation to various external and internal conditions the before named movements. (3) *Chemical Changes;* these are briefly sketched as not only those directly concerned in the contraction of muscle, but as occurring in all parts of the body. They may be regarded as a slow combustion in which complex substances full of latent energy are reduced to simpler stable conditions with less or with no latent energy. Like St. Paul, the animal, says Dr. Foster, "dies daily." "All the inner labour of the body, both that of the chemical gland-cells, of the vibrating nerve-substance with its accompanying changes of consciousness, and of the beating heart and writhing visceral muscles, is, sooner or later, by friction or otherwise, converted into heat; and it is as heat that the energy evolved in this labour leaves the body." Only as heat or as motion of limbs, jaws, &c., does the energy set free in the animal body make itself externally apparent. This combustion and degradation of material necessitates new supplies, and hence we have the phenomenon of the inception of food and the chemical processes connected with it.

The Problems of Physiology are then stated as the result of the preceding survey of the actions of a living being to be as follows:—(1) To discover the laws of transmutation of complex unstable food into still more complex living flesh, and the laws by which the latter breaks down into waste products, void of energy. (2) To discover the laws of the origin of nervous vibrations, of their passage to and fro in nerve substance and of their ultimate disappearance in connection with muscular contraction or otherwise. (3) To discover the laws of how the energy of chemical action is transmuted into and serves as the supply of that vital energy which appears as movement, feeling, and thought.

This rough analysis of the problems of physiology is "the residue of many successive phases of opinion." It is in tracing the influence of these successive phases and estimating the value of their residues that the skill of Prof. Foster is most successfully exerted. Such an appreciation of the historical significance of the various factors of his science, should, we think, be as much the indispensable possession of a cultivated specialist as is a knowledge of his country's political history to the statesman.

The exigencies of life, Dr. Foster tells us, early directed man's attention to the phenomena of the animal body and thus brought the study of physiology to the front before its time. Hence in the absence of the knowledge of physics and chemistry, explanations were assigned to those phenomena of animal bodies which were not obviously identical with those of inanimate bodies, under the names "vital spirits" and "animal spirits." In the seventeenth and eighteenth century, however, the progress of anatomical knowledge led to the perception of the fact that the animal body contained, if it did not actually consist of, a number of mechanical contrivances each of which could be shown to perform some service in the animal economy for which its construction especially fitted it. In this way grew up the doctrine of "organs" and "functions," and it was held that the inspection of structure was sufficient to enable an acute observer to determine the particular function of any given part. Great progress was made under the influence of this doctrine—the most notable example of its triumph being the discovery by Harvey of the function of the heart and the mechanism of the circulation of the blood. The doctrine of vital and animal spirits still survived as giving an explanation of the motive force which set the complicated machinery of connected organs at work.

In the physiological "cell-theory" of Schleiden and Schwann the adequacy of the doctrine of organs and functions to explain the phenomena of life, whilst apparently finally established, received, according to Dr. Foster, its death-blow. It appears to us that Dr. Foster does not quite give its true significance to "the cell-theory." It is true that the founders of that theory attached undue importance to the structural characters of the cell. But Schwann at any rate attached the greatest importance to the cell-substance, and to its molecular and atomic constitution, and the doctrine that function is dependent on structure, when by structure we understand not merely coarse visible structure, but molecular structure, which differs in any two cases by a difference of internal movement of molecules rather than by a difference of their permanent position—this doctrine is triumphant to-day, and is proclaimed in that portion of the present article which treats of different kinds of protoplasm.

A quotation is given from a well-known article by Prof. Huxley, written thirty years ago, in which it is stated that cells "are no more the producers of the vital phenomena than the shells scattered in orderly lines along the sea-beach are the instruments by which the gravitative force of the moon acts upon the ocean." Apparently Dr. Foster thinks this statement to be defensible even to-day, but the conception of living matter and of the significance of cell-substance and structure thus indicated appears to us to be more difficult to reconcile with the modern doctrine of protoplasm than is the doctrine of Schwann, which, to use his own words, was "le contraire de la théorie generalement admise pour les animaux, d'après laquelle une force commune construit l'animal à la manière d'un architecte," and which argued from the uniform construction of organisms by modification of the nucleated corpuscles called cells that "c'est partout la même force qui reunit les molécules en cellules, et cette force ce ne pouvait plus être que celle des molécules ou des atomes; le phénomène fondamental de la vie devait donc avoir sa raison d'être dans les propriétés des atomes"—that is to say, in the atoms of the substance of which the cells consist which has now received the name protoplasm.

Dr. Foster next gives a vivid picture of the importance of the discovery by Claud Bernard of the glycogenic function of the liver—a function which could not be inferred from the inspection of the liver either macroscopic or microscopic. Such discoveries as these led to the recognition of the existence of most important processes or "functions" in the animal body which had no correlative in visible structure. Thus physiologists were led to see in the mind's eye the invisible structure of cell-substance and the "protoplasm theory" obtained its foundations.

A brief survey of the life of a corpuscle of protoplasm as exemplified in an Amœba follows, and attention is directed to the *constructive* and *destructive metabolism* going on in the substance of such an organism. There are anabolic and katabolic changes in that substance, which may be compared to a double flight of stairs leading up to and down from a hypothetical summit; that summit is what we mean by protoplasm, but whether the term should include a few of the steps up or down or be limited to the top plane cannot at present be decided.

This protoplasm of the unicellular organism exhibits properties which may be classed as (1) *Assimilation;* (2) *Contractility;* (3) *Irritability* or *Sensitiveness.* From the consideration of these we are led on to that of a simple multicellular organism—a Hydra—in which a first stage of differentiation of these properties between two groups of cells—the endoderm and the ectoderm—is observed. Then in due course the further differentiation of these two primary groups of cells in a higher animal is traced—in an account of the organs and tissues with their specialised properties and functions derived by gradual modification from the lower stage of differentiation.

The relation of the complex organs, composed of numberless cell-units, of a higher organism to the practically homogeneous protoplasm of a single cell-corpuscle having thus been traced, Dr. Foster takes one organ of a higher animal—the kidney—as an example of the problems which present themselves to the modern physiologist. There are, he points out, two points of view, two aims of inquiry which pursue in many respects different methods, though ultimately blending and tending conjointly to the explanation of the action of the kidney. They are distinguished as the "mechanical" and the "molecular," and correspond in these later days to the earlier and later standpoints of physiology represented by the doctrine of organs and the doctrine of cell-substance. The physiologist's inquiry is sketched from the first point of view, and it is pointed out that this inquiry "takes on to a large extent the characters of an attempt to unravel an intricate game, in which the counters are nervous impulses, muscular contractions, and elastic reactions, but in which the moves are determined by topographical disturbances and mechanical arrangement." The second kind of physiological inquiry into the kidney ignores for the time being these grosser conditions, and is directed to the molecular action of the protoplasmic cells which build up the distinctive structure of the kidney, namely, its tubules.

Reverting to "a brief survey of the whole field of physiological inquiry," Dr. Foster says:—"The master tissues and organs of the body are the nervous and muscular systems, the latter being, however, merely the instrument to give expression and effect to the motions of the former. All the rest of the body serves simply either in the way of mechanical aids and protection to the several parts of the muscular and nervous systems, or as a complicated machinery to supply these systems with food and oxygen, *i.e.* with blood; and to keep them cleansed from waste matters through all their varied changes."

That, no doubt, is true if the organism be viewed as an individual and not from the point of view which regards the individual as one of a race and the race as part of the general outcome of organic development, and this as again a part of a more general phenomenon. The biologist who takes his stand on the doctrine of evolution must, we venture to think, regard as the "master-tissue" over and above those indicated by Dr. Foster—the reproductive tissue or the specific cells of the ovary and testis. It is in every animal this little nest of germ-plasma handed on from generation to generation with scarcely a change which receives the homage and service of all the various products of differentiation of its brother-cells. The latter are but the carriers, protectors, and servants in the struggle for existence of the undifferentiated germ-plasma—even the cells concerned in thought and reason exist but to protect the germ-cells. The former perish as a mere husk whilst the germ-plasma is immortal; it forms, by growth and fission, on the one hand, new germ-plasma which never dies, and on the other hand protecting tissue-cells, which have only an evanescent existence. As Dr. Foster himself has elsewhere said:—"The animal body is in reality a vehicle for ova, and after the life of the parent has become potentially renewed in the offspring the body remains as a cast-off envelope whose future is but to die."

In the latter part of the article our present knowledge of the nature of protoplasm, and of the processes which go on in connection with it, is forcibly sketched. Different *kinds* of protoplasm are recognised, the differing qualities of which are to be regarded by the biologist as "the expression of internal movements" of the molecules of the protoplasm. The term "mesostate" being used to express those ascending and descending steps of the pyramid whose summit is protoplasm, and "anastate" and "katastate" corresponding respectively with those constituents of cell-substance which are on their way to attain, and those which are falling away from the state of perfect protoplasm, we find that the tendency of inquiries into the molecular processes taking place in living secreting cells, in muscular tissue, and in the various forms of nerve-tissue, "is to lead us to regard the varied activities of these tissues as due to molecular disruptive changes in their several katastates, these being various stages of the downward metabolism or katabolism of protoplasm."

Hering's recent speculations on the relation of colour sensations to the condition of the protoplasm of the percipient cells lead, Dr. Foster thinks, to a new molecular physiology. He gives us the hope that by an application of Hering's conceptions (which the limits of our space do not permit us to notice more fully) to other groups of protoplasmic units a new departure may be effected, and that we may look forward to a very great advance in our knowledge of the nature of the processes taking place in living cells.

Dr. Foster concludes his article with an outline of the methods of physiological inquiry and an unanswerable though brief exposition of the dependence of the progress of physiology upon experiment on living organisms.

The article on Pianoforte is of considerable interest for several reasons; first, because it is signed with the initials of Mr. A. J. Hipkins; secondly, from the number and felicity of the illustrations; thirdly, because it takes up a special and somewhat neglected point in the history and development of the remarkable instrument which has superseded the far more ancient organ, and which has become the domestic companion and indispensable accessory in thousands upon thousands of households throughout the civilised world.

Probably no man living knows so much about the pianoforte as Mr. Hipkins: attached for many years to the honoured house of Broadwood and Sons; almost able to remember its original title of Tschudi and Broadwood, which carries us back at one bound to the epoch of the harpsichord Mr. Hipkins is not only an experienced musician, but an excellent physicist in his special line. He has read valuable papers before the Royal Society, and efficiently co-operated with Mr. Alex. Ellis in his laborious determinations of pitch and of oriental or archaic musical scales.

The somewhat neglected subject here given with the terseness and accuracy of a monograph, as is proper in a work somewhat of the nature of an index, is the mechanical development of the modern pianoforte from the earliest form of keyed instrument with strings, shown in a drawing by Miss Edith Lloyd of a sculpture in St. Mary's Church, Shrewsbury belonging to the first half of the fifteenth century. Besides this and other woodcuts of typical instruments, is a series of diagrams showing the various forms of "tangent," "jack," "hammer," "action," and "escapement" by which the sounding string has been successively made to vibrate with ever increasing fulness and beauty of tone and quality. Towards the end of the article the recent substitution of metal for wooden framings is similarly summarised and illustrated. No doubt much of this would be hard reading for an unmechanical student; but it was really needed, and as a compact whole could hardly be said to exist previously.

The early part of the article appeals to every reader, and is full of fascinating and original research. There are eleven other capital woodcuts besides that named above of clavichords, clavicymbalums, spinetts, and clavicytheriums, which, under a multiplicity of names, preceded the four "gravicembali col piano è forte," which Cristofori, the Paduan harpsichord maker had, on the undoubted authority of the Marchese Scipione Maffei, completed in the year 1709. This date may be looked on as the birthday of the name and the instrument. Originally adjectival and explanatory, it has been adopted substantivally wherever this ubiquitous form of the "dulcimer with keys," as Mr. Hipkins quaintly defines it, has penetrated.

BALL'S "STORY OF THE HEAVENS"

The Story of the Heavens. By Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland. (London, Paris, New York, and Melbourne: Cassell and Co., Limited, 1885.)

POPULAR works on astronomy, either on its entire range or selected portions, have been so numerous of recent years as to make it difficult to judge a new one entirely on its own merits; it is felt that there must be some well-marked originality of plan or execution, some novelty of treatment, or freshness of fact, to justify an addition to an already abundant literature.

The present work can urge its claim to a favourable reception on a twofold ground; it is the fullest and most complete exposition of the leading facts and principles of astronomy which has yet been laid before the entirely unscientific public, and it devotes special attention to some of the most recent and interesting astronomical discoveries. It is in no sense whatsoever a student's book, but aims to give, in such simple and untechnical language as may be most acceptable to the general reader, a comprehensive view of the results of astronomy as at present received. So thoroughly is it elementary in character that Dr. Ball from time to time seems to think he has a childish audience before him, and descends to a style which is nowadays considered almost too condescending to be addressed even to children. Thus, in speaking of the distance of the sun, he says (p. 28):—

"The actual distance of the sun from the earth is about 92,700,000 miles; but merely reciting the figures does not give a vivid impression of the real magnitude. 92,700,000 is a very large quantity (*sic*). Try to count it. It would be necessary to count as quickly as possible for three days and three nights before one million was completed; yet this would have to be repeated nearly ninety-three times before we had even counted all the miles between the earth and the sun."

But though Dr. Ball may sometimes resort to this infant-school style he never falls into the opposite fault of being turgid or obscure. His language is always clear and distinct, and when treating of the particular subjects most congenial to him he usually succeeds in avoiding the fault we have just noticed, and his style leaves nothing to be desired.

In a brief introduction Dr. Ball indicates the principal questions which it is the business of the astronomer to seek to answer, and glances at some of the most important discoveries made by the ancients, concluding with the labours of Copernicus. The main volume then commences with a chapter on the astronomical telescope. The Dunsink South equatorial, the great Vienna refractor, and Lord Rosse's 6-foot reflector are described, and illustrations given of them; the Paris meridian circle is represented as a type of meridian instruments, and a well-written page (p. 22) is devoted to drawing a contrast between the ideal instrument and the actual one.

A number of chapters on the different members of the solar system follow. These occupy more than half the volume, and do not call for much special comment, for, whilst travelling over such well-trodden ground, there is but little scope for original treatment. The author throughout gives a clear matter-of-fact account of what he has to describe; there is never for a moment any difficulty in following his meaning, and for a work of this character this is a first essential. The chapter on the Sun is perhaps the least successful. Dr. Ball considers that it is not proved that "sun-spots are really depressions in the surface"; a statement which may be perfectly correct if "proved" is to be taken in its hard mathematical sense; but it ought to be supplemented by the further one that the entire evidence is in favour of that supposition. No reference is made to the frequently-repeated coincidences of solar outbursts and magnetic disturbances which were observed in 1882 and 1883, and which placed the connection of the two orders of phenomena in such a striking light. And again with reference to the spot-cycle, the nature of the cycle is rather crudely stated, and one of its most curious features—the change of latitude in the *locale* of the spots—is altogether unnoticed. Chapter III., on the Moon, contains a little sketch-map of the moon and descriptions of the most striking formations. The laws of eclipses, the use of the moon in navigation, and Nasmyth and Carpenter's theory of the volcanic origin of the lunar craters are treated of with the author's usual clearness and at considerable length. In the concluding paragraphs Dr. Ball expresses his belief that forms of life unknown to us may probably exist on many of the celestial bodies, and applies to the question of the plurality of worlds the lines of Tennyson :—

> "This truth within thy mind rehearse,
> That in a boundless universe
> Is boundless better, boundless worse."

The fourth chapter deals with the solar system as a whole, with the detection and identification of planets, with the positions and dimensions of their orbits and their own comparative sizes. It is followed by a chapter on the Law of Gravitation, a most important one, and admirably written. The law of gravitation is so important in itself, and so little understood by the unscientific portion of the public, that such an explanation as is here supplied is much needed.

The succeeding chapters deal with the planets one by one, beginning with Vulcan, the "Planet of Romance," which Dr. Ball is inclined to believe was really seen by Prof. Watson during the total solar eclipse of 1878, on the not unreasonable ground that an observer of his experience and skill was not likely to have been mistaken. In the chapters on the other planets the points to which most attention has been paid are the descriptions of the various modes of determining the sun's distance, and the size, form, and weight of the earth. There is a pleasing and somewhat full biography of the elder Herschel in the chapter on Uranus, and the wonderful story of the discovery of Neptune is told again in a fresh and engaging style. Leaving the regular members of the solar system, we come to the comets and shooting-stars, and with these Dr. Ball begins to treat his subject in a somewhat more original manner, and there is very much to commend in these and the following chapters. Encke's comet, the evidence it affords as to a resisting medium, and its usefulness as a means of determining the masses of Jupiter and Mercury and the distance of the Sun, occupy a considerable space. Bredichin's theory of comet's tails is clearly explained. Dr. Ball is, however, scarcely correct in authoritatively classing the great comet of 1843 as a non-periodic one, and the similarity of its orbit to those of the great comets of 1880 and 1882 surely deserved a word of notice. In the chapter on shooting-stars he draws a sharp distinction between meteors and meteorites, and expresses his conviction that Prof. Newton was wrong when he spoke of a meteoric stone as having probably been part of a comet. He also broaches and supports by some ingenious reasoning the idea that meteorites are largely of terrestrial origin, and he points out that meteorites of iron are much less frequent than those of stone.

Chapter XVIII. is on "The Starry Heavens," and is especially commendable for the series of little diagrams in which the relative positions of the principal fixed stars are shown with admirable distinctness. Nothing can be easier than for the reader with this portion of the book in hand to make himself acquainted with the general configuration of the northern constellations. Several instructive points are well brought out in the two following chapters, but in Chapter XXI., on the Distances of the Stars, we find Dr. Ball on ground which he has largely made his own. Herschel's attempt to form a conception of the distribution of the stars in space is clearly explained, and made the basis of a detailed description of the method of determining the distance of a star by its annual parallax, and the cases of 61 Cygni, α Centauri, and Groombridge 1830 are dealt with at considerable length. The difficulties of parallax work are sympathetically described, and the drawback often experienced of a long series of observations failing to show any parallax at all is made the occasion for enlarging on a particular instance of such a failure, viz. Nova Cygni, 1876. The chapter concludes with an explanation of Herschel's discovery of the motion of the solar system towards the constellation Hercules. The spectroscope is much more sparingly dealt with, and the entire range of astronomical spectroscopy is despatched in one of the shortest chapters in the book. It is not possible that so condensed an account should be very thorough or complete, but, given the necessity to confine the subject within these limits, it is difficult to see how it could have been much better done.

The three following chapters deal with Star Clusters, and Nebulæ, Precession and Nutation, and the Aberration of Light. Each of these subjects is well handled; the explanations of the three kinds of apparent motion shown by the stars being clearly and carefully explained, without going into any details which would be likely to prove too abstruse or tedious for any ordinary reader. The chapter on Nebulæ is illustrated by three plates, one of which, Trouvelot's drawing of the Great Nebula in Andromeda, is very well executed.

The two concluding chapters are of especial interest. Chapter XXVI., on "The Astronomical Significance of Heat," deals with the most important points in the history and method of the evolution of the solar system; the presence of heat in the body of the earth, the law of cooling, the heat of the sun and its possible sources, the doctrine of energy, the nebular theory and the evidence which supports it. With respect to this last it should be observed that the old illustration of the trees in the forest is by no means very apposite. Dr. Ball is, however, careful to distinguish such a theory, however magnificent and attractive, from the truths of astronomy properly so called.

From nebular evolution we pass naturally to tidal evolution. It is but comparatively recently that Dr. Ball's lecture upon this subject was reported in these pages, so that it is only necessary to say that the romantic story is well told this second time. The criticisms to which the theory was subjected are not referred to here, though some deserved greater consideration than to be silently passed over.

As we have already said, this is in no sense whatsoever a student's book. Dr. Ball has already shown how well qualified he is to produce such a work when he desires to do so, but he has had an entirely different purpose here. It may be doubted whether he has not in some instances been too general and undefined in his mode of treating his subject; the explanation of the principles and methods involved in the determination of the sun's distance by means of Transits of Venus, for example, is particularly meagre and unsatisfactory. The public that does not care to have to exert much thought over its reading is not the public that will purchase books on astronomy 550 pages in length; an occasional light article in a magazine will satisfy its utmost craving.

Nevertheless a book which in a lucid and easy style supplies accurate and the latest information as to the methods and discoveries of astronomy, which is written by a competent authority, and which, if not profusely illustrated, is supplied with plates and woodcuts which leave no important object unrepresented, no fundamental argument unsupported, can only be spoken of as a good one; and those who wish to possess a full, interesting, and popular account of the present state of the most noble and enthralling of all the sciences cannot do better than make themselves possessors of the "Story of the Heavens."

OUR BOOK SHELF

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1883. (Washington: Government Printing Office, 1885.)

THIS is the most bulky, and perhaps the most valuable, of these well-known Reports; it consists of very nearly 1000 pages, and we learn, from the resolution of Congress which precedes it, that 16,060 copies have been printed. The more strictly official part of it deals with the Smithsonian Institution and the Natural History Museum, including the Report of the Committee on the Henry statue recently erected in the grounds; but, besides these, we have Reports on the various branches of science, so valuable that no scientific library should be without them. Astronomy has been taken in hand by Prof. Holden, the newly-appointed Director of the Lick Observatory; meteorology, by Mr. Cleveland Abbe; physics, by Prof. Barker; zoology, by Prof. Guild; and anthropology by Mr. Otis T. Mason, the latter covering nearly 200 pages. Other branches of science besides those which we have named are reported at less length.

When we consider the importance of these *résumés*, and the fact that 7000 copies of the volume are being distributed gratuitously by the Institution all over the world, we may readily concede that in this, as in their other duties, the Regents of the Institution are faithful to the trust imposed upon them by Smithson to promote the increase and diffusion of knowledge among men.

The Sun: a Familiar Description of His Phenomena. By the Rev. Thomas William Webb, M.A., F.R.A.S. (London: Longmans, 1885.)

THIS is a little book of seventy-eight pages, containing what appears to have been a lecture given by the author, who, to the great loss of observational astronomy, died a short time ago. That part of it which deals with the telescopic facts is very much more in harmony with our present knowledge than that smaller part of it which deals with the revelations of the spectroscope. The whole is very charmingly and simply written.

Notes on the Physiological Laboratory of the University of Pennsylvania. By N. A. Randolph, M.D., and S. G. Dixon. (Philadelphia, 1885.)

THIS little volume consists of a series of short papers giving the results of practical investigations into the behaviour of certain substances, such as starch, cod-liver oil, boiled and unboiled milk, &c., when used as articles of food by infants and adults. Many of the papers are of interest; all of them show evidence that in the University of Philadelphia, physiology is not taught as a matter of book-learning, but that the students are instructed in the practical bearings of the science.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Lieutenant Greely on Ice

I HAVE read with deep interest the graphic but brief account of Lieut. Greely's Arctic explorations given in NATURE of November 26 (p. 90), and also in some of the Scottish papers, which touch upon subjects not mentioned in NATURE.

Assuming that these reports are, in all material points, correct, I ask leave to be permitted to offer some remarks on a few of the opinions expressed by the distinguished explorer, the correctness of which seems open to question.

Before doing so, however, I would draw attention to the very considerable difference in the mean yearly temperatures at Discovery Bay, as given by the English Government ship that wintered there in 1875-76, and that of Lieut. Greely wintering at the same place six or seven years later.

Capt. Stephenson, H.M.S. *Discovery*, 1875-76 ...	$-4^{\circ}\cdot23$ F.
Lieut. Greely, in house six or seven years later, about	$+4^{\circ}\cdot00$
Making a difference of	$8^{\circ}\cdot23$

I suppose the thermometers to be in both cases correct, and the mean temperatures computed in the same manner in each case. In saying that "Grinnell Land has the lowest mean temperature in the globe," surely Lieut. Greely goes a little too far, as no observations have elsewhere been made in so high a latitude, nor at any point in the great circle of 1100 miles' diameter *nearer* to the Pole than Discovery Bay, in nearly all parts of which it would be a very natural conclusion to arrive at, that the mean temperature would be lower. Lieut. Greely adds, "This" (the lowest temperature in the globe) "was in accordance with their expectation."

Kane went to the Arctic Sea with "expectation" and a belief that he would find an open Polar sea! His steward, Morton, conveniently found it for him, and it was *believed* in for a time, until other expeditions passed the place where "Morton's pool" of open water had been seen; but alas! not a trace of it could be found, although ships had gone by, creeping along shore, some hundred miles further north. The distinguished Greenland explorer Rink, finally, effectually demolished this Arctic dream. Lieut. Greely's open Polar sea of 1100 miles' diameter round the Pole seems to be a myth of a somewhat similar kind. It is purely a theory, with facts, to my mind, adverse to its probability; for why this immense body of water in the far north, whilst constantly sending forth great ice-streams southward through the broad inter-Greenland-Spitzbergen Channel, should be itself ice-free, whilst other seas far southward, having a much higher temperature, and probably with currents and gales of wind at least as strong, are ice-encumbered, is rather difficult to understand.

As regards floebergs, Lieut. Greely has advanced their size and thickness far beyond anything one would infer from reading the narrations of the English Expedition of 1875–76, which first gave the name to those curious masses of ice. He has not only done this, but he attributes their formation to a source which completely destroys the meaning of the name "floeberg," used in contradistinction to "iceberg," to show that the former has its origin from the floe or sea ice, instead of from ice formed on land, and is either built up by the gradual increment of the floe and the snow that falls upon it, or, as I believe more likely, by a number of floes being forced by immense pressure one over the other, until great thickness is attained. Perhaps the best example of a floeberg (according to my idea) that I can give, is that which lifted the ship of the Austrian Expedition seventeen feet (I think) out of the water, became a great floating mass of ice in a week or less, a mile in extent and of great thickness, and carried those good explorers Weyprecht and Peyer helplessly about for a long time in 1873-74, in Barentz Sea, then landed them safe on one of the Francis Joseph Islands; thus leading to the discovery of this great Northern land. Snowdrifts would in the course of one winter (I have seen a fifteen feet depth of drift in one night) fill up most of the inequalities of surface, and thus the floeberg is complete.

Lieut. Greely says that these "floebergs are simply detachments from slowly-moving glacial ice-caps, from an ice-covered land in the neighbourhood of the Pole;" that "Dr. Moss (of the *Alert*) was certainly correct as to the universality of stratification in this *ancient* ice, and he concurred in the Doctor's opinion, that its salinity was due to efflorescence and infiltration."[1]

First as to the formation of these floebergs; Lieut. Greely tells us they are detached from an ice-cap 1000 to 4000 feet thick near the Poles. Surely if this were so, some of these great masses, which would show about 140 feet above water, would have been seen by Parry, when in the summer of 1827 he was in lat. 82° 45′ N. (only thirty-nine miles south of Greely's extreme) to the north of Spitzbergen; but neither Parry nor any of the brave whaling captains, who have gone to high latitudes between Greenland and Spitzbergen—the great highway of northern ice in its southward drift—have ever seen anything of the kind.

In the Antarctic we all know that such ice-mountains (the source of which Sir James Ross's discoveries tell us of) drive down to lat. 60° S. near to Cape Horn; the natural idea is, that they would do the same thing in the Arctic Sea—in company with the great ice pack, through the wide high road above mentioned—and not confine themselves to the coast seen by Lieut. Greely's party.

A word or two on my own experience much further to the south. When passing in my boats for 800 or 900 miles along the west shores of Hudson's Bay in 1846 and 1853, I saw several floebergs aground, some thirty or forty feet above the surface, so large and high that any one at a distance of a mile or so, would have mistaken them for true icebergs; they were merely a mass of floes forced together by strong winds. In such low latitudes (58° to 66°) these spurious icebergs all disappeared before autumn.

No true iceberg that breaks away from land-ice is ever found, as far as I know, to contain saline strata, as the late Dr. Moss found to be the case with the floeberg from which the crew of the *Alert* in 1875-76 took the ice, for drinking or making tea. Sometimes this ice was so salt as to be unfit for the purpose, although high above the sea-level. This result is attributed by both Dr. Moss and Lieut. Greely to "infiltration." I cannot understand how saline fluid could "infiltrate" *upwards* from the sea into ice—a solid—in which there would be no pores through which it could flow, apart from the fact of the greater specific gravity of the brine.

I do, however, know from personal experience that saline fluid does, under certain circumstances, percolate or filtrate *downwards*, converting sea-ice, previously saline, into a sufficiently fresh state to afford good drinking-water when thawed. This discovery, like a good many others of more importance, was accidental. In passing a piece of old ice—that is, of a former year's formation, which was known to be so by its wasted and rugged outline, as it stood some feet above the surrounding level ice-floe—I knocked a small piece off, and on putting it into my mouth, found it quite fresh. From that time, during sledge journeys of 1200 miles in the spring of 1847, I looked out for some old rough ice, before building our snow-hut for the night's shelter, so as to get water quickly.

Experience had taught me that a kettleful of water could be obtained much more rapidly and at a far less waste of fuel by thawing ice than from snow, because the latter, however closely packed, contained much air, which, at a temperature of zero or lower, required extra fuel to warm it *up* to 32° Fahrenheit; a kettleful of snow will give little more than a third of a kettleful of water, whilst the same measure of ice will nearly fill the kettle with water.

The fresh ice I speak of could not be part of an iceberg, because there were no bergs in the great bay where we were travelling. Moreover, if a piece of this ice (which was fresh at a few feet above the sea-line) was chopped off on a level with or below the water-line, it was found to be saline.

How does this take place? Simply, I imagine, by the brine or saline fluid filtrating downwards through pores made by itself in the ice, as soon as the summer temperature became high enough to thaw the saline part, the fresh portion retaining its solidity, with the exception of the minute pores worn out as above described.

My belief is that the floebergs seen, and so named by the English Expedition of 1875–76, were formed of saline sea-ice, piled one floe over another, and that when the summer temperature penetrated them to a certain extent, the salinity filtered downwards as above described, but that certain layers or strata, either from not being subjected to a sufficient rise of temperature or from some other cause, still retained their saltness.

All sea-ice has a surface-layer, more or less thick, of brine efflorescence, far more saline than the body of the floe. If, then, six or eight floes are forced up, the one over the other, there will be so many layers of these thin very saline strata.

I repeat that infiltration *upwards* in this case is contrary to all aws of gravitation, unless those learned in chemistry or physics can show that there is some powerful attraction or affinity to drag a saline fluid upwards through a dense solid.

This communication has gone far beyond the limits I intended, and yet is very short of what might be said on other parts of Lieut. Greely's lectures in Scotland. I must conclude by expressing my admiration of the great amount of geographical work done by this expedition, and the miraculous rescue of the few survivors where twenty-four hours' delay would have been fatal, resembling in this respect very closely the rescue of a *part* of a Government overland expedition in Arctic America sixty-four years years ago, who, but for the arrival of friendly Indians with food and most tender nursing of them, could not have lived more than a couple of days longer.

4, Addison Gardens, Kensington, Nov. 28 JOHN RAE

P.S.—The *Scottish Geographical Magazine* has just reached me, by which I find Greely's mean temperature of his winter quarters to be −4° F. instead of +4°, therefore almost exactly the same as the temperature found by the English Expedition of 1875–76, instead of there being 8° difference—as I put it.—J. R.
December 7

[1] I met the late Dr. Moss at the British Association when held some years ago in Dublin. We conversed a good deal on the above subject. I learnt from him, if my memory is correct, that the floeberg from which the crew of the *Alert* took the ice to thaw for their use, was found to have strata too saline to drink. This explanation I think requisite.—J. RAE.

The Recent Star-Shower

IT being important to ascertain the duration of the recent shower of Andromedes, observations were continued here on the night of November 30. During a watch maintained for about four hours and a half between 5h. 30m. and 10h. 15m., ten Andromedes of most certain character, together with two other meteors, in reference to which some doubt existed as to their absolute identity with this stream, were recorded from a radiant-point carefully determined at $21° + 42\frac{1}{2}°$. Thirty-one non-conformable shooting-stars were also seen from showers in Perseus and the region eastward.

It is therefore clear, from the results obtained on November 30, that the display had not lost its visible character, though it had evidently subsided into a state of great feebleness. It yielded certainly not more than three meteors per hour for one observer, and these were extremely faint.

On the evening of December 1 the sky was again clear. A prolonged watch of the region of Andromeda then revealed no trace of the display. Meteors were very rare, generally, all the evening. On December 4 they were very frequent, but the radiant-point near γ Andromedæ gave no sign. The ζ Taurids and Geminids (which are specially mentioned in the current number of NATURE (p. 108) as deserving observation during the present week) were both visible, and a number of contemporary streams had come actively into play. But, during long watches on the nights of December 1 and 4, there was no appearance of outlying Andromedes. The cessation of the shower definitely occurred between November 30, 10h. 15m., and December 1, 5h. 45m., after an *observed* duration of little more than five days. But this period unquestionably fails to represent the real duration, for, could observations have been made before moonrise on the early evenings of November 24 and 25, there is no doubt it would have been detected. We can hardly admit a sudden rise of the shower from invisibility on the 25th to a degree of richness on the 26th sufficient to give more than 100 meteors per hour. It is to be hoped that reports from other stations will throw some light on the visible development of this remarkable stream. In any case the extremely narrow limits of its display on November 27, 1872, offers a strong contrast to the comparatively prolonged duration observed at its recent return.

Bristol, December 6 W. F. DENNING

WHILE watching the meteor shower of the 27th ult. I observed what closely resembled the appearance of an aurora. There was seen extending along the horizon from about south to about west-north-west—perhaps further towards the north, for my view was there obstructed—and upwards for about 20° from the horizon, a faint reddish-pink luminous haze, varying fitfully in colour, becoming sometimes nearly white, and in intensity both as regards time and position. The greatest brightness noticed by me was nearly due south. Stars were clearly visible through it.

On referring to the letters in NATURE upon the shower of November 27, 1872—to refresh my memory upon other points—I found that appearances of an aurora on that evening are recorded by "several correspondents." [Mr. Denning's letter in NATURE, December 5, by Father Denza in Piedmont (NATURE, December 19), by Mr. Baber at Liverpool (same number), and the Hon. Mr. Newton and Mr. Bruce at Mauritius ("a pulsating coruscation, similar to the appearance of the aurora australis"), NATURE, January 23, 1873]. NATURE for January 16, 1873, contains a letter recording a "pale auroral light" seen at the same time as a shower on December 7, 1838, and Mr. Denning (April 24, 1873), records that the April shower was accompanied by "bright displays of auroræ."

Mr. Newton and Mr. Bruce add that "the instruments at the Observatory gave no indication of a magnetic disturbance."

Some of your readers may be able to say whether any magnetic disturbance was observed on the evening of the 27th ult. I saw the auroral appearance about 7.15 p.m.

Rugby, December 7 J. B. HASLAM

P.S.—In a note received to-day in answer to my inquiry, the Superintendent of the Kew Observatory kindly informs me that at Kew the "magnetic curves for horizontal intensity, vertical intensity, and declination were remarkably steady throughout the whole of the 27th and 28th ult., being almost straight lines at the time of the meteoric shower." He adds that no auroral effects were seen at Kew.—J. B. H. (Dec. 8.)

IN case England has been clouded on the 27th, it may be well to state that the meteors were brilliantly seen in the Adriatic. A few were visible on the night of the 26th; on the 27th, at 16h 30m. G.M.T., they averaged thirty per minute; at 17h. they had much increased, and were counted, at 18h. 10m., at seventy per minute, while at 20h. 40m. they had decreased to thirty per minute again; on the 28th very few were seen. During the rapid shower they were not equally distributed; for six or eight seconds only one or two were to be seen, and then, in a couple of seconds, perhaps eight would be counted, mostly seen simultaneously. The radiant-point was estimated at about 15° S. of the following end of Cassiopeia at 16h. 30m., and at about 3° S. of the preceding end at 20h. 40m. The trails were more persistent and brilliant in the latter part of the evening. One was distinctly seen by two observers to sharply bend its apparent course about 20°, possibly a case of perturbation by a non-luminous meteor, or else of splitting. A large number were as bright as first-magnitude stars, and many equal to Venus. WM. F. PETRIE

s.s. *Tanjore*, November 28

FROM the accounts in NATURE and in the *Times*, it is evident that the display of meteors was much finer in the east of Switzerland than any of those mentioned by your correspondents. My attention was first directed to the shooting-stars shortly after 6 o'clock (local time here being about thirty-eight minutes in advance of Greenwich time). For half an hour after that time the fall was continuous, several meteors appearing together. In fact, so many were falling, that it seemed to me hopeless to attempt to count them, but I should think that they must have fallen, on a moderate computation at that time, at the rate of at least 200 a minute. Many of them were especially brilliant, and those falling near the mountains, which completely encircle this village, produced, I presume by irradiation, the curious appearance of passing between the spectator and the mountains. The richest period of the display when, looking from a window, four or five were seen together in one part of the heavens did not last for more than an hour, but the phenomenon continued with less effect until 9 o'clock, when the sky which, until that time had been perfectly clear, became overcast. The height of the high-lying plateau of the Canton Grisons, more especially in the Engadine, and the remarkable absence of aqueous vapour, causes many more stars to be visible here than in the denser air of England, and this, no doubt, in large measure, accounts for the superior brilliancy of the display as witnessed here. This strangely affected the imagination of some of the peasants of this village, one young woman in particular spent the evening in tears and lamentations, momentarily expecting the end of all things. J. F. MAIN

Wiesen, Canton Grisons, Switzerland

"Evolution without Natural Selection"

TWO or three points in Mr. Romanes's letter in your issue of December 3 (p. 100), leave me no other alternative than to again ask you to insert the following few remarks. I beg to inform Mr. Romanes that with Darwinism my book has very little to do. It neither attempts to refute nor confirm the Darwinian hypothesis of Natural Selection. Neither is it an "emendation of Darwinism"; but the facts it contains seem to be an all-necessary supplement to the great naturalist's hypothesis. It is to be regretted that at the present time so many naturalists accept the theory of natural selection as an exclusive explanation of the evolution of existing species. They unconsciously blind themselves to the existence of any other agent in the work of evolution. To them there can be, nor is, no other. No greater error could be made; and it is my firm conviction that as time goes on the theory of natural selection will gradually lose much of its present presumed universality. What is becoming more evident every day is that existing species do not owe near so much to natural selection for their evolution as extreme Darwinians would have us believe. What the remote ancestors of these species derived from its influence is another matter. How far its influence has been exerted on living forms is not for me even to conjecture; but certainly, so far as birds are concerned, the evidence of its influence is astoundingly slight in comparison with the number of species.

I am very pleased to see that Mr. Romanes has changed his opinion concerning "trivial specific characters," and now admits that they are both numerous and important. But they cannot even be regarded as "insignificant" as compared with the great "organising work of natural selection." For, according to the Darwinian theory, they should owe their very presence to its influence, but, unfortunately for the hypothesis, they do not. Once more I must strongly protest against Mr. Romanes saying that my book attempted to explain the *cause* of variation. It does nothing of the kind. Nor do I consider it fair for Mr. Romanes to infer that isolation, &c., do not explain the cause of variation, and therefore that they fail as evolutionistic agents. It would be just as fair and logical to say that the Darwinian hypothesis is a failure because it does not explain the cause of variation. Darwin must have a variation to begin with for natural selection to work upon; so must isolation. The cause of variation is one of the greatest secrets which Nature still retains in her keeping; but doubtless it will soon be wrested from her.

London, December 6 CHARLES DIXON

I HAVE not changed any of my views; but Mr. Dixon appears to change his within the limits of two consecutive sentences. For, immediately after his strong protest against my statement that he has attempted to explain the causes of variation, he complains of my want of fairness in not acknowledging the adequacy of the "evolutionistic agents" which he has suggested as "the causes of variation." With this specimen of Mr. Dixon's method of discussion before them, your readers may be able to sympathise with the failure which seems to have attended my efforts at expounding his essay.

The analogy between isolation and natural selection does not hold. For is it not obvious that while natural selection can be understood to operate in an explicable manner on the variations supplied to it, there is no analogous explanation to be given of the manner in which isolation can so operate—*i.e.* why isolation *per se* should preserve some of the variations and not others? That isolation is a favourable *condition* to the occurrence of trivial or non-adaptive specific change, I have not denied; but, on the contrary, expressly affirmed: I have only denied that it can be regarded as the *cause* of such change—and least of all in any way similar to that in which natural selection may be regarded as the cause of important or adaptive specific change. Therefore, if it is the case that "so many naturalists accept the theory of natural selection as an exclusive explanation of the evolution of existing species," I think that Mr. Dixon has done well to correct their error. Only I am not aware that any naturalist of note has allowed his belief in Darwinism thus to go beyond the teaching of Darwin.

GEORGE J. ROMANES

Scandinavian Ice-Flows

FAILING any more direct answer to Sir J. D. Hooker's query (NATURE, vol. xxxiii. p. 79), perhaps, with your usual courtesy, you will allow me space for one or two brief notes. The map referred to, as it stands in "Climate and Time," p. 449, is conjectural to a very large extent. If we are to take the relative closeness of the lines to indicate comparative depth and strength of the glacier-flow, the Baltic must have been, at the intensest period of glaciation, a glacier-filled valley, on an enormous scale, with the ice-stream passing out over the comparatively low, and then submerged, country of Schleswig-Holstein. Dr. Croll, to support a foregone conclusion, represents it thus, and then makes it bifurcate conjecturally about the Dogger Bank. One or two considerations, however, make Dr. Croll's conclusion less "inevitable" than he seems to imagine (p. 449).

(1) Admitting, as we must, that the striations mentioned (p. 448) on the Island of Bornholm, point to the passage of ice in massive proportions over at least that island in the *direction* indicated by the lines on the map, we may still call in question the hypothesis which regards the *main mass of the Baltic ice* as having passed that way.

For (2) the evidence given (p. 449) of its having passed over Denmark (the bare "fact that the surface of the country is strewn with debris derived from the Scandinavian peninsula") is so ambiguous as to be worthless on the point under consideration.

(3) The *facts* stated by Dr. Croll (stripped of the guise with which he has invested them) can be easily and naturally accounted for by the action of *marine* ice, owing its origin to the great Scandinavian glaciers of the period; some of which, even from the Baltic side, probably drifted away into the present North Sea basin.

But (4) that *the main mass* of the ice from the *eastern* slopes of the great glaciated Scandinavian range did not take this direction is proved by some of the best-established facts of European geology; facts which, had they been known to Dr. Croll, would have rendered, I venture to think, the construction by him of the map referred to impossible. On p. 447 he says, "After passing down the Baltic, a portion of the ice would probably move south into the flat plains in the north of Germany, but the *greater portion* would keep in the bed of the Baltic, and of course (*sic*) turn to the right round the south end of Gothland, and then cross over Denmark into the North Sea."

The *naïveté* of this statement, in a book bearing date 1875, is truly refreshing. Any one who knows the district of Jena is perfectly familiar with the enormous abundance of ice-transported material from Scandinavia to be found thereabouts; and these "Findlinge" are spread far and wide over the whole North-German plain as far inland as Bonn, Westphalia, Thüringen, Saxony (even to the south of Zwickau), and, according to Credner's later observations (*Sitzber. der naturforsch. Gesellschaft*, Leipzig, 1875), into the interior of Bohemia, as far as Troppau, near the sources of the Oder, on the slopes of the Sudeten Gebirge, and even to Toula and Moscow.

(5) Lastly, the occurrence of striated blocks of Scandinavian origin in the boulder-clays of the Yorkshire coast, is clearly incompatible with the conjectural view so graphically expressed on the map in question. A. IRVING

Wellington College, November 30

The Resting Position of the Oyster

I FEEL some disinclination to take up more space in the pages of NATURE on this subject without making any new contribution to the discussion, but Mr. John A. Ryder's letter induces me to summarise the facts which have been brought forward, and the conclusions to be drawn from them. The condition of the oysters examined by me can only be explained by inferring that they were quite free, and resting on a flat bottom with the right valve downwards. The specimens of *Pecten opercularis* which I had before me were in the same condition, and doubtless rested in the same position. Of *Pecten maximus* I cannot speak with certainty, and therefore leave to Mr. Arthur Hunt the responsibility of stating that there is a difference in respect of position in the two species. Prof. Möbius also finds that the left valves of oysters are usually covered by fixed animals, but as far as I understand his letter he thinks this does not prove that the left valves in this condition were uppermost: in the oysters I examined, the right valves were so clean that they must have been in close contact with the bottom. The other letters on the subject all describe evidence proving that oyster larvæ attach themselves by the left valve. This I did not deny, and I might of course easily have found the direct testimony of observers on the subject. Mr. Ryder says it is well known that the right valve of the oyster is always the most deeply pigmented, while the left one is paler; in the oysters I examined, the condition of the valves was exactly the reverse of this. It seems to me that when a young oyster is attached to the under-surface of a stone or shell by its left valve its right valve is lower, and if it drops from its attachment, or grows much larger than the stone or shell to which it is fixed, the surface of its right valve will come into close contact with the sea-bottom. I have seen oysters which still retained a piece of shell attached near the umbo of the left valve, while the rest of the valve was covered with fixed animals, and the right valve was quite clean and light in colour. There are no crowded oyster-banks in the Firth of Forth, and it might even be said that the oysters which came under my observation had been dredged and thrown overboard again at some time of their lives. But I do not think oysters are often returned to the water when once taken in the Firth. In my former letter I implied that probably in the normal position of an adult oyster the right valve was in contact with the bottom. That this is often the case when the oyster is free and has plenty of room has not yet been disproved, and therefore I think the current statement that the oyster, when not attached, invariably rests with its left valve downwards needs modification. J. T. CUNNINGHAM

Scottish Marine Station, November 28

The Sea-Mills at Argostoli

I WILL be glad if, through the columns of your journal, you will be good enough to inform me what has been written in English concerning the phenomenon known as "The Sea-Mills at Argostoli." Having recently visited the island of Cephalonia I was able to examine these mills frequently, and I have reasons for believing that papers have been read at different times at some of the learned societies at home discussing the subject *in extenso*. I will therefore be glad of *any* intelligence on this interesting phenomenon which you may be able to refer me to. J. LLOYD THOMAS

H.M.S. *Téméraire*, Mediterranean, November 15

Earthquake

ON Thursday morning, December 3, I was in bed awake, between 6 and 7 o'clock. I heard a slight clattering noise of the earthenware and glass articles on the marble top of the washstand. It lasted for about three seconds, and went .... with a slight halt near the end. There was no one moving in the house, and nothing outside to cause the tremors, which I did not feel in bed. I immediately got up to look at the clock, and found it was 6.45. I do not know at what time the earthquake in Algeria took place, possibly there was some connection between the two, and the tremor may have been felt in other places in England, so I record this.

Gateshead, December 6 R. S. NEWALL

VENTILATION

IN modern life, with its enormous populations living under artificial conditions in towns and cities, the subject of ventilation, or the supply of sufficient pure air to each individual for the maintenance of health, has assumed, as it has become more generally understood, a vast and national importance. Its importance has been clearly demonstrated in many instances by a greatly diminished death-rate in places where overcrowding on space or in houses, formerly existent, has been remedied, and especially by a decrease in those diseases which are now generally recognised as preventible. Thus, since attention has been paid to the amount of cubic space and the supply of fresh air per head in barracks, the death-rate from phthisis or destructive diseases of the lungs in the army has fallen from 10 to 2 per 1000; and typhus, formerly very prevalent in the gaols of the country and in the crowded courts of our large cities, is now almost unknown in these situations. That there is still a vast amount of disease and death which could be prevented by a more general recognition of the absolute importance of a pure supply of fresh air under all conditions, is a fact whose truth we recognise when we observe the numbers of scrofulous and ricketty children and consumptive adults in our large centres of population. Many houses in the poorer parts of towns are absolutely debarred from obtaining fresh air and light by their surroundings. Built almost back to back, or fronting into narrow courts or passages closed at one or both ends, the sunlight never penetrates for months in the year, and a free current of air is an impossibility. Fortunately the Legislature has recognised this evil, and the Acts known as Sir Richard Cross's and Torrens's are intended to remedy such a state of things, and, where enforced, have succeeded in removing buildings which no structural alterations could improve. The erection of huge blocks of Industrial Dwellings, whilst affording vastly superior accommodation to the working classes, has not always secured efficient ventilation in these respects for certain of the tenements. We have seen instances of lofty blocks being built in such a way as to enclose a narrow and well-like court, in which the atmosphere is always stagnant, and from which the inner rooms derive all their light and air. Cottage buildings, with sufficient space in front and rear, are far preferable to lofty blocks placed in rows; but as they do not house the same number of people for the space occupied in crowded districts, where land is of such enormous value, the rents must necessarily be higher, the other accommodation being the same. The air of enclosed courts is often damp, and being stagnant allows suspended particles to fall and foul gases to accumulate in it, thus forming a suitable "nidus" for the growth and cultivation of such disease germs as are capable of existing in the air. It is true that the death-rates appearing in the reports of many of the Industrial Dwellings Companies' are exceptionally low, but we must remember that a very large proportion of the working clases die in hospitals and not in their own houses, and such sources of error require to be very carefully eliminated. Of late years Artizans' Dwellings have been built on better principles, the experience derived from the sanitary failures of certain of the earlier erections having been taken to heart.

In the model bye-laws of the Local Government Board it is provided that no new street is to be less than 36 feet in width, that the frontage of any new building not standing in a street shall be at least 24 feet in width, and that there shall be an open space at the rear of any new building and belonging to it of an aggregate extent of 150 square feet, this space not to be in any case less than 10 feet wide, and if the height of the building exceed 35 feet, to be not less than 25 feet wide. If these rules could be always enforced in the cases of new buildings an improvement would be gradually effected in and around towns in the poorer districts which is greatly needed.

From what has been said it will be seen that one of the principal points in any system of ventilation is that the air to be admitted into a building should be pure, and this can be ensured if there is no impediment to the free circulation of currents of air on the outside. We come now to the second part of the subject, viz. the vitiation of air that is constantly going on in inhabited places from the respiration of men and animals, and from the combustion of gas, lamps, and candles, and the methods by which this vitiated air may be replaced by pure external air. The composition of the atmosphere is as follows in 1000 parts: nitrogen, 790·0; oxygen, 209·6; carbonic acid gas, ·4, and traces of ozone, ammonia with nitrous and sulphurous acids in the air of towns, and a variable amount of aqueous vapour. The air taken into the lungs of a human being has this composition, but that expired differs from it in the following particulars, the nitrogen remaining the same: the oxygen which is the vital principle of air is diminished 4 per cent., the carbonic acid is increased 4 per cent., the expired air is saturated with aqueous vapour and is heated nearly to the temperature of the body, 98° Fahr., and contains a small proportion of foul, decomposing organic matter, which exists partly in the form of vapour and partly as solid suspended matter (epithelial dust and scales). This organic matter, though small in amount, is the most injurious quality of expired air, giving to the atmosphere of an ill-ventilated room its close and disagreeable smell. Those who are familiar with the interiors of courts of law, with the pits and galleries of theatres, or with crowded buildings generally, are also familiar with the headaches, the lassitude, and the "malaise" produced by breathing for some hours a vitiated atmosphere. In analyses of such air nearly ten times more carbonic acid has been found than is normally present in the outer air, and when this excess is known to mean a deficiency in oxygen and a corresponding excess in organic vaporous exhalations and suspended matter from the breath and bodies of the persons present, the foul nature of the atmosphere can be realised. The slow deterioration in health, which results from the constant breathing of foul air, is one of its most important results, and causes a predisposition to, and lessened power of, resistance to attacks of disease.

An adult man of average size takes in and breathes out, when at rest, about 30 cubic inches of air at each respiration, this act being performed about seventeen times in a minute, so that in one hour about 17 cubic feet of fresh air will have been vitiated to the extent of containing 4 per cent. of carbonic acid—that is to say, about ·7 cubic foot. Such a man gives out when at rest, therefore, nearly ·7 cubic foot carbonic acid gas per hour. Now it has been found by Dr. De Chaumont, by chemical examination of a large number of samples of the air of inhabited rooms, that the amount of carbonic acid in the outer air being ·4 per 1000, no close smell is perceived in the air of a room until the carbonic acid reaches ·6 per 1000, or exceeds by ·2 per 1000 that in the outer air, the close smell being always due to the foul organic matter in the impure air, which increases *pari passu* with, and is therefore estimated by the amount of carbonic acid present. It has been assumed by De Chaumont, and experience has fully confirmed this assumption, that we can breathe with immunity air vitiated to this slight extent, but that we should not allow any greater vitiation. We may take it, therefore, that the object of ventilation is to supply sufficient pure air to a room to prevent the carbonic acid rising above ·6 per 1000, this quantity being known as the limit of respiratory impurity. It may be asked why should not the air of our rooms be as pure as the air outside? No doubt this would be desirable, were it not that it involves a continual renewal of the inner air by the outer, which means in cold weather an unceasing draught at an unbearable temperature. We have seen that an ordinary adult man expires ·7 cubic foot of carbonic acid in one hour when at rest, now if such an individual were enclosed in an airtight chamber, 10 feet high, 10 feet wide, and 10 feet long—that is to say, in a chamber containing 1000 cubic feet space—in one hour the carbonic acid in this chamber would have had added to it ·7 cubic foot of carbonic acid; the air originally contained ·4 parts of carbonic acid in 1000 parts, so that after one hour it would contain ·4 + ·7 = 1·1 parts of carbonic acid per 1000, or 1·1 − ·6 = ·5 parts per 1000 above the permissible limit for health. But if the subject of our experiment were enclosed in a room containing 3500 cubic feet of space, in one hour the amount of carbonic acid would be only $\frac{3·5 \times ·4 + ·7}{3·5} = ·6$ per 1000, *i.e.* the limit would have just been reached, and at the end of a second hour, to keep the carbonic acid to this limit, another 3,500 cubic feet of fresh air must have been allowed to enter the room. That is to say, an adult man requires when at rest 3500 cubic feet of fresh air per hour; a woman or child requires proportionally less. For any individual above twelve years of age, we may take as an average the amount of carbonic acid expired per hour as ·6 cubic foot, and for such an average individual 3000 cubic feet of fresh air per hour is necessary. We can now appreciate the importance of cubic space, for if we are to supply 3000 cubic feet of fresh air to every individual above twelve years in a room, and the amount of space, suppose, in a dormitory where ten persons sleep is only 300 cubic feet per head, then 30,000 cubic feet of fresh air must be supplied per hour—that is to say, the air of the dormitory must be completely changed ten times in this period, a proceeding which would cause in any but the very warmest weather a very disagreeable draught. But if the cubic space per head be 1000 feet, then the air of the dormitory need be changed only three times per hour, and if such renewal be effected steadily and gradually no draught need be felt. We may mention here that a certain amount of superficial or floor space is necessary for each individual, for if the height of the room is much over 12 feet, excess in this direction does not compensate for deficiency in the other dimensions, although the cubic space may be the same; thus it would not be the same thing to allow a man 50 square feet of floor space in a room 20 feet high, as to allow him 100 square feet of floor space in a room 10 feet high, although the amount of space allotted to him in each case would be the same. It may be interesting here to mention that in common lodging houses under police regulations, 240 cubic feet of space are allotted to each adult, in barracks about 600 cubic feet, in general hospitals about 1000 cubic feet as a rule, and in infectious fever hospitals from 1500 to 3500 cubic feet—in these latter institutions the floor space allowed per bed is from 150 to 300 square feet. From the report of the royal commission on the housing of the working classes it would appear that even the low allowance of the common lodging houses is very often not attained in the crowded rooms of tenement houses, and an enormous number of cellars are still inhabited in our large towns, although they presumably come up to the requirements of the Public Health Acts as regards their ventilation.

Gas, candles, and lamps use up oxygen and produce carbonic acid and water. A cubic foot of coal gas produces, when burnt, 2 cubic feet of carbonic acid, and since a common burner consumes 3 cubic feet of gas in an hour, it produces 6 cubic feet of carbonic acid in the same period. Therefore, as much air should be supplied to dilute the products of its combustion as would be necessary for three or four men. It is far better, however, to use such gas-lamps as are shut off from the air of the room. These receive the air necessary for combustion from without, and the products of combustion are carried off by a special channel to the outer air. The electric light uses none of the oxygen of the air and gives off no carbonic acid nor water, and is for these reasons far preferable to naked flames for lighting purposes.

Ventilation is said to be carried on by natural or by artificial means. In the former are included (1) diffusion of gases; (2) action of the wind by perflation and aspiration; (3) movements caused by differences in weight of masses of air at different temperatures. By the latter, although the same principles are involved, is meant exhaustion of air by heat or by steam from apartments, or propulsion of air into such spaces by mechanical means, as fans. Diffusion causes a rapid mixing of different gases placed in contiguity; thus the gaseous impurities of respired air mix with the fresh air in a room until homogeneity is established. Diffusion, however, does not affect the suspended matters which tend to fall in a still atmosphere. Consequently organic matters which exist principally as minute solids in a state of suspension in the air, are not affected or removed by diffusion. The wind when in motion causes a partial vacuum in the interior of tubes, such as chimneys and ventilating shafts placed at right angles to its course. The air in these tubes being thus partially aspirated or sucked out by the action of the wind, to restore the temporary vacuum so made, air from below rushes up to take its place, a continual current in a perpendicular direction being thus set up. Perflation by winds is the setting in motion of masses of air by the impact of other masses. This action is illustrated when the windows on opposite sides of the room are fully open. The room is rapidly and continually flushed with air, an enormous effect being produced, for it has been estimated that the air of such a room may be renewed many hundred times an hour, even when the movement of air outside is only 2 miles an hour or 1½ feet per second, equivalent to a very gentle and almost imperceptible breeze. Such a method is of unquestionable utility for rapidly changing the air of an unoccupied room, and may be generally put in operation in summer in inhabited rooms when the temperatures outside and inside the house approximate. In any system of ventilation that depends entirely on the wind there is always the difficulty of regulating the velocity of the current according to the amount of movement of the air, and during complete calms the action is nil. For ventilating the holds and interiors of ships at sea, the wind may be most advantageously utilised. A cowl placed so as to face to the wind conducts the air below, whilst another reversed so as to back to the wind allows the used air to escape.

The movement due to masses of air at different temperatures is the natural force chiefly relied on for ventilating the interior of houses. The air of inhabited rooms in this climate, except in warm summer weather, is at a higher temperature than the outer air; hot air is lighter than cold air, and will rise for cold air to take its place—in fact, heated air is displaced upwards by colder and denser air. In a room as usually constructed with sash windows, with a fire-place and chimney, but without any special means of ventilation, when a fire is burning in the grate the heated air of the room in part ascends the chimney-flue, and in part rises to the ceiling. Cold air from outside will then enter, if the windows be closed, under the door, under the skirting boards, between the sashes of the window, and through any other chinks or apertures due to loose fittings. The bricks and plaster of the walls are also porous to a slight extent, and if not covered with paint or wall paper will admit air to a limited extent. Thus a large volume of air may be entering a room in cold weather when the fire is burning although there be no visible inlets, and the amount of air thus supplied may be sufficient for the needs of two or three persons if it were properly distributed. But such is not the case. The cold air, which enters chiefly near the floor, takes as straight a course as possible to the fire-place, producing a disagreeable draught to the feet of the occupants, whilst the heated and vitiated air near the ceiling is left undisturbed. It has been found practically that to prevent draughts, and to ensure a thorough distribution, fresh air should be admitted into a room above the heads of the occupants, an upward direction being given to it, so that it may impinge on the ceiling, mix with, and be warmed by, the heated air in this situation, fall gently into all parts of the room, and be gradually removed by means of the chimney-flue or any other outlet. The inlet openings for fresh air now most in use are intended to serve this purpose. For sash windows Hinckes Bird's method, now so well known, of placing a solid block of wood under the lower sash of the window so as to raise the top of the lower sash above the bottom of the upper, admits the air in an upward direction to the ceiling above the heads of the occupants. Holes bored in a perpendicular direction in the bottom of the upper sash, louvered panes to replace one of the squares of glass, an arrangement for allowing one of the squares of glass to fall inwards upon its lower border and providing it with side cheeks, or a double pane of glass in one square open at the bottom outside and at the top inside—all effect the same purpose and are simple and inexpensive contrivances. Wall inlet ventilators, as the Sherringham valve and Tobin's tubes, are constructed on the same principles, fresh air, which in towns may be filtered through muslin or cotton wool, or made to impinge upon a tray containing water so as to deposit its sooty particles, being admitted at a height of about 6 feet from the floor and directed upwards towards the ceiling. The usual outlet for vitiated air is the chimney-flue, and this for an ordinary medium-sized sitting-room, with a fire burning, is sufficient for three or four people, provided no gas is alight, or the gas lamp has its own special ventilating arrangements. With an ordinary fire, from 10,000 to 15,000 cubic feet of air are drawn up the chimney in an hour. Valves placed so as to open into the flue near the ceiling are sometimes used as outlets for foul air, such are Neil Arnott's and Boyle's valves, which permit air to pass into the flue, but prevent its return; the only objections to their use are that they occasionally permit the reflux of smoke into the room, and their movements backwards and forwards cause a slight clicking noise. In all new buildings where efficient ventilation is desired, it would be preferable to construct a shaft at one side of, or surrounding the chimney-flue, with an inlet near the ceiling of the room and the outlet at the level of the chimney top, so that the air escaping from the room would have its temperature kept up by contact with the chimney, thus aiding the updraught, whilst the risk of reflux of smoke would be avoided. In all new domestic buildings a very great improvement might be effected by providing for the warming of the air before its entry into the apartments. The window and wall inlet ventilators just described are occasionally productive of draughts in cold weather, so that it is more usual to find them closed or stopped up than in action, or else admitting a very insufficient supply of air; but if the air be warmed before admittance to an agreeable temperature a very large amount may be allowed to enter without the fact being known to the occupants. The ventilating stove invented by Captain Galton, the Manchester school grate, and other forms effect this purpose in the following manner: Behind the grate, which is lined with fire-clay, is a chamber into which fresh air is admitted by a pipe from the outside. The air, here warmed, is admitted into the room by a pipe opening at about the level of the chimney breast and guarded by a grating which can be opened or closed as found convenient. In the Manchester school grate the warmed air is admitted by vertical pipes, like Tobin's tubes, opening on a level with the chimney-piece. The danger in these grates is that cracks may be formed by the heat of the fire in the joints or in the cast-iron plates which surround the air chamber, and thus direct communication be established between the grate and air chamber with the result of deleterious products of combustion being admitted into the air of the room. When the stove is lined with fire-clay there is no danger of the air in the chamber being overheated, producing charring of the organic matter in the air and an offensive smell, which is so often noticed around stoves where this precaution has not been taken. In Mr. Saxon Snell's ventilating thermhydric stove the fresh air is warmed by passing over hot water pipes in the stove before entrance into the room, the hot water being derived from a small boiler at the back of the grate. The temperature of the water is not high enough to overheat the air.

Gas is being gradually introduced for heating purposes, and with a reduction in its price we may look forward to its more extended use. There are several ventilating gas stoves by which air is admitted into a room warmed after passing through the stove. It is important to regulate the heat carefully so as not to overheat the stove and the air which is passing through. In churches and other public buildings air is usually warmed before entry by passing over hot water pipes which circulate around the building under the floor. In all large buildings the combustion of gas may be made a very effective means of getting rid of foul air. It has been found by experiment that the combustion of one cubic foot of coal gas causes the discharge of 1000 cubic feet of air. In theatres where gas, although being gradually replaced by the electric light, is still much used, the extraction of foul air from the roof of the building by the sunlight burners presents no difficulty. The difficulty experienced is the introduction of fresh air from below without causing draughts. In private houses the use of an extraction shaft over the gas chandelier or a Benham's ventilating globe light, or a Mackinnel's ventilator greatly aid the extraction of foul air from the ceiling, whilst the two latter are also useful in providing inlets for fresh air which enters slightly warmed near the ceiling, and is then directed horizontally by flanges so as to be distributed over the room. Outlets in the ceiling of a room may become inlets when a strong fire is burning, as the draught up the chimney will overbalance the extractive power of the gas and cause all other openings into the room to be inlets. We may here mention an ingenious method for warming the air admitted by Tobin's tubes into a room: a row of small Bunsen burners encircles the tube at its foot, and the products of combustion are conveyed away by a tube which surrounds the Tobin and opens into the outer air.

In large public buildings, where expense is no object, a combined method of ventilation by propulsion and extraction presents many advantages. The amount of air admitted can be easily regulated, warmed, cooled, or moistened, and freed from impurities by filtration, and enormous volumes are capable of being so supplied by propulsion and removed by the extractive powers of a furnace. In the Houses of Parliament where this system is in operation, air is propelled by rotatory fans along conduits to the basement, where it is warmed in winter by passing over steam pipes, and then passes upwards through shafts into the space beneath the grated floor of the House. The heat can be regulated by covering the steam pipes with woollen cloths, and in summer the entering air can be sprayed with water or cooled by passing over ice in the conduits. The vitiated air in the House passes through a perforated glass ceiling in the roof, and is then conducted by a shaft to the basement of the Clock Tower, where it passes into the flue of a large furnace.

The introduction of electricity for lighting and of gas for heating purposes will, in the case of both public and private buildings, considerably modify the methods of ventilation now most generally used.

CYCLES

THE Institute of Mechanical Engineers held a general meeting in the Corn Exchange, Coventry, on the afternoon of Wednesday, October 28, Mr. Jeremiah Head, President, in the chair, when the Secretary read a paper by Mr. R. E. Phillips, of London, "On the Construction of Modern Cycles," of which an abstract follows:—

The cycle industry in this country has grown with such rapidity and has already assumed proportions of such magnitude as to lead the author to hope that the present paper may prove of some interest to the Institution. It would not be possible within any reasonable limits to do justice to all matters connected with cycles; and he therefore purposes dealing only with their general construction, pointing out the underlying principles, and describing the various types at present made in order to show how far these principles have been carried out, and what degree of perfection has already been attained.

Power.—The experiments of Messrs. S. J. and G. S. Stoney show that with a lever action bicycle the power necessary to produce speeds of from six to fourteen miles an hour on an average road ranges from one-seventh to one-third of a horse-power; but the author thinks that less than this would be necessary with an ordinary rotary action bicycle.

Bicycle.—Gavin Dalzell, a cooper of Lesmahagow, in Lanarkshire, in 1836 first fixed a pair of cranks to one of the wheels of a hobby horse, and may therefore be considered the inventor of the bicycle. In 1868, Mr. Cowper, a past President of the Institution, specified, amongst other things, suspension wheels with wire spokes, hollow felloes, rubber tyres, and anti-friction roller bearings, and may thus be considered the inventor of the suspension wheel. Without these features or some modifications of them no cycle at the present day is satisfactory.

Tricycle.—Although the tricycle was invented contemporaneously with the bicycle it did not attract much attention until six years later.

Statistics.—Over one thousand patents were applied for for improvements relating to velocipedes before the end of 1883, and during 1884 (under the new Act) 637 applications were filed. There are 170 firms who devote themselves exclusively to cycle making, and turn out over 500 different machines. The trade employs 3000 men in Coventry and at least 5000 in the United Kingdom. About 40,000 machines are sold annually, of the gross value of about 800,000*l.*

Performances.—The following "records" are given:—

On a Racing Path

Distance run, miles	Duration of race, hours: Bicycle	Duration of race, hours: Tricycle	Mean speed, miles per hour: Bicycle	Mean speed, miles per hour: Tricycle
1	0·044	0·050	22·6	20·0
5	0·238	0·272	21·0	18·4
10	0·489	0·543	20·5	18·4
20	0·985	1·145	20·3	17·5
25	1·278	1·442	19·6	17·3
50	2·733	3·054	18·3	16·4
100	5·835	6·726	17·1	14·9

On Ordinary Roads

Journey	Bicycle: Hours	Bicycle: Days	Tricycle: Hours	Tricycle: Days
Distance of 100 miles	7·19	—	7·58	—
Land's End to John O'Groat's (about 900 miles)	160·17	= 6·67	197·33	= 8·22
Land's End to John O'Groat's and back, and thence to London, about 2050 miles	456	= 19		
Greatest distance in 24 hours	266¼ miles		231½ miles	
Mean speed for the 24 hours, miles per hour	11·1 ,,		9·6 ,,	

From these performances it appears that the bicycle has an advantage of from 2 to 2½ miles per hour.

Classification—

Bicycles

1. Bicycles of the ordinary type.
2. Safety Bicycles, which may be subdivided into—
   a. Dwarf bicycles with geared rotary action.
   b. Dwarf bicycles with lever action.
   c. Safety bicycles with steering-wheel in front.
3. Tandem bicycles.
4. Otto bicycle.

Tricycles

1. Single drivers, which may be subdivided into—
   a. Rear steerers.
   b. Coventry rotary, side steerer.
   c. Double front steerers.
2. Double drivers, which may be subdivided into—
   a. Those driving by clutch action.
   b. Those driving by differential gear.
3. Humber tricycles.
4. Hand power tricycles.
5. Sociables.
6. Tandems.
7. Carriers.

All these may be again subdivided as driven by "rotary" or "lever" action.

BICYCLES

Ordinary Bicycles.—The ordinary type of bicycle is so familiar that it need not be referred to at any length, especially as the details of construction will be dealt with later on. Being supported on only two points it is unstable, so it tends to fall one way or the other. Equilibrium is maintained by steering to that side to which it tends to fall. As the rider is seated only a little behind the centre of the driving wheel he is able by his feet alone to control the steering and so maintain his balance. When working the rider must counteract the thrust of his feet by pulling at the handle bar with his arms alternately on either side. It is this combined action which renders the riding of a bicycle so difficult to learn. The bicycle cannot be driven along a perfectly straight line, hence anything that interferes with the freedom of steering, as the groove of a tram line, makes the balance impossible.

Weight.—The weight of an ordinary roadster bicycle varies from as many pounds as its driving wheel is inches in diameter down to from 15 to 20 lbs. less than this. A racing bicycle weighs from 18 to 25 lbs., according to size. The proportionate weights of the several parts were given.

Vibration, which is the chief source of discomfort in most cycles, is mitigated by the use of india-rubber cushions between the wheel bearings and the forks, between the backbone and the spring, and between the head and the handle.

A spring fork was shown which serves to diminish the vibration produced by the small wheel of a machine.

Dwarf Bicycles with Geared Rotary Action.—Machines of this class have a smaller driving wheel connected with the pedals by chains and chain wheels. This makes it possible to "gear up" the driving wheel so as to be equivalent to one of any size. The high gearing thus introduced is the cause, in the author's opinion, of their ease of propulsion and speed.

Dwarf Bicycles with Lever Action.—The "Facile" bicycle is a prominent example of this type of machine. The motion of the feet is simply reciprocating, and as the wheel is not "geared up" the feet keep time with the driving wheel.

The 'Xtraordinary is another example of a lever action machine. In this machine the fork rakes back to a great extent so that the rider is far behind the centre of the driving wheel, but the pedal levers bring the pedals to a convenient position. Their path is oval. These machines are made of the full size.

Safety Bicycles with Steering Wheel in Front.—In machines of this class the rider sits well over the driving wheel, which is behind. A single chain is sufficient, as in this kind of machine there is a "through" crank-axle. In a modification of this pattern a divided crank-axle is employed, which allows the rider to be still more over the driving wheel. The frame, moreover, is made capable of swinging and of being locked in various positions, so that the rider can place himself in the best position under all conditions.

Machines of this type are rather sensitive in the steering, but as automatic contrivances to keep the steering wheel running straight are apt to interfere with that freedom which is necessary for the balance, such devices are not altogether desirable.

In these machines the feet cannot be used to control the steering as in an ordinary bicycle, but the author of the paper has contrived a means for effecting this. On the centre of the crank axle is a spherical boss, on which can swivel, but not turn freely in all directions, a large double hollow chain wheel kept parallel to the driving wheel by two idle rollers. As a matter of fact the crank axle swivels within this chain wheel and the brackets which support it being rigidly connected with the handle bar serve to steer the machine.

Tandem Bicycles.—At present there are only two makes of tandem bicycle, each invented by Mr. Rucker. The earlier one is constructed of two ordinary bicycle driving wheels complete in their forks, which are then connected by a backbone containing an axial joint. Each rider drives, steers, and balances on his own wheel independently of the other, but of course the rear must follow within a foot or so the path of the one in front. Although this machine is very fast, lighter than two ordinary bicycles, and almost entirely free from vibrations, there is an element of danger about it that militates against its general use, inasmuch as it demands to a certain extent a unity of thought and action on the part of both riders.

A very satisfactory tandem has been arranged by the author, a modification of this, in which the rear wheel is replaced by the driving wheels of an ordinary Humber tricycle, the connecting bar of course being modified to suit the altered conditions. The later tandem bicycle eclipses the earlier; it is probably the fastest machine in existence. It is constructed on the lines of a dwarf geared bicycle. The seat for the front rider is mounted immediately over the centre of the driving wheel, while the rear rider who alone steers and manages the machine is about midway between the two wheels. Divided pedal axes are mounted fore and aft of the centre of the driving wheel. The weight of this bicycle is only 55 lbs.; it is therefore the lightest machine yet made to carry two riders.

Otto Bicycle.—This peculiar machine, which is due to the brother of the inventor of the gas engine known by the same name, is almost more nearly allied to a tricycle than to a bicycle proper, but as it has only two wheels and consequently requires the balance to be still maintained by the rider, it is rightly called a bicycle. The wheels are the same size, and are here mounted loose on the same axle, parallel to each other and both of them are drivers. The rider sits between them and works a continuous pedal crank-axle, the position of which when he is seated is below and slightly in front of the axle carrying the driving wheels. The crank axle is connected with the driving wheels by endless steel bands passing round plain pulleys on the ends of the crank-axle and on each wheel. The bands are kept taut by tightening springs, and the machine is steered by slacking one or other of them, which causes the corresponding driving wheel to lose motion, and therefore the other wheel runs round it. If a very sharp turn has to be made suddenly, a brake is applied to one wheel at the same time that its driving band is slackened, which causes the machine to turn round in a circle upon that wheel as a centre. This machine having no small wheel fore or aft, the rider, while steady sideways, has to balance himself in the direction of his motion, which he is enabled to do through the medium of the pedal crank axle; by pressing on the forward pedal, if he is falling forwards, he throws his weight backwards and conversely by pressing on the rear pedal he throws his weight forwards. To preserve him from actually capsizing backwards a safety tail projects behind the seat, which will bear on the ground whenever the seat is tipped too far back.

Among the many beautiful features presented by this machine the best seem to be: (1) the balance whereby the rider is always in the best position to utilise his strength and weight notwithstanding the various gradients; (2) the nicety by which it can be steered; (3) its tendency to run in a straight line without any effort on the part of the rider; (4) its freedom from vibration; (5) the circumstance that it makes only two tracks.

TRICYCLES

The tricycle presents far greater difficulties than the bicycle. It is necessary that each wheel shall be free to move in its own direction independently of the united action of the other two. For running in a straight line all three wheels must be parallel; whilst for running round a curve, one or more of the wheels must be turned until the centre lines of the axles intersect in plane, their point of intersection being the centre of the path described. Besides being independent in direction of running, each wheel must also be capable of revolving at a greater or less speed than the others. It is also essential that only so much of the rider's weight shall be borne by the steering wheel or wheels as is necessary to ensure their proper action. Owing to the variety of ways in which these principles can be carried out practically, it is easy to account for the variety of tricycles constructed.

Single-driving Tricycle.—The simplest form of tricycle is that with only one driving wheel, either or both of the others being used for steering. The single driving rear-steerer is now practically obsolete.

Coventry Rotary Tricycle.—Another single driver, known as the "Coventry rotary," has the large driving-wheel on one side, and two small steering wheels on the opposite side, arranged to turn together in contrary directions for steering. The double steering counteracts the evil of one-sided driving. Though one of the first machines introduced it is still largely in use, its advantages being that it is simple, it makes only two tracks, and it is narrow enough to pass through an ordinary doorway; this, however, diminishes its natural stability.

Front Steering Tricycle.—A single driving machine of this class exists which is steered by the two front wheels, and driven by the rear wheel, but there is not sufficient weight on the driving wheel.

Double-driving Tricycles.—In these the two driving wheels are always placed parallel and opposite to one another, with the steering wheel in front or behind, and generally central. It is sometimes placed on one side when the tricycle makes only two tracks. There are two methods of double-driving: firstly, by clutch-action; secondly, by differential or balance gear.

Double-driving by Clutch Action.—In this plan the two driving wheels are locked to their axle only when the machine is being driven forwards in a straight line, but in running round a curve the outer wheel overruns the clutch and the inner wheel alone drives. In the Bourdon Clutch, which is most generally used, a disk has its edge cut away so as to form three or more inclined planes. In each of the spaces between these recesses and an outer ring is a hard steel roller, which jams when the clutch drives the wheel, but which does not hinder the wheel from running ahead of the clutch.

A clutch machine cannot, without extra gearing, be driven backwards, nor can it be retarded except by the action of the brake. On the other hand the free pedal is a convenience. Various attempts have been made to construct a clutch which shall drive either way, but hitherto without success, in consequence of the loss of time between the forward and the backward grip. The author of the paper is now at work on this problem.

Double Driving by Differential or Balance-Gear.—This other mode of double driving, so called because the power is divided or balanced between the two driving wheels, depends on the action of an epicyclic train, in which the two primary wheels are connected with the driving wheels of the tricycle, while the arm or train which connects them is driven. The simplest form invented by Starley consists of three bevel wheels. Here the arm or axis of the middle one being carried round, drives the other two and hence the driving wheels, which nevertheless can move independently. Other gears were spoken of, and a figure of the Sparkbrook gear given.

Each kind of driving has its advantages. When running straight the clutch system drives each wheel, and when one wheel meets with more resistance than the other, as much extra force as is necessary is supplied to it, so that obstacles are surmounted with less chance of swerving. In going round a corner only the inner wheel is driven.

With balance-gear the same force is applied to each wheel, whether the path is straight or curved.

A rear steering tricycle driven by clutch action, a rear steerer driven by differential gear, and a front steerer driven by differential gear were exhibited.

Humber Tricycle.—Among tricycles driven by differential gear, the Humber is quite peculiar. The rider sits astride a back bone carrying a trailing wheel, and steers by turning the axle of the two driving wheels by means of a handle bar. The differential gear is essential to a machine of this type, as it does not interfere with the steering, while it is at all times perfectly double driving.

A curious machine—a modification of the Humber—was shown, in which all three wheels take part in the steering, but of entirely novel and elegant design.

As with bicycles, so with tricycles, the power may be applied in one of two ways: either by rotary action or by lever action. For changing the power, levers are more convenient, but they do not compare with rotary action in point of speed.

Omnicycle.—One of the most successful lever machines is the omnicycle, a machine in which the pedals are connected with the circumference of a segment by means of a leather strap. When one pedal descends it causes the segment on the other side to return and raise the pedal on that side. The segments can be expanded to various extents, so that the power is applied with various degrees of leverage according to the work to be done.

Direct-Action Tricycle.—The simplest rotary tricycle has no chain or connecting mechanism; the pedals are on the main axle, which is cranked. This gives rise to the insuperable objection of instability as the rider is necessarily perched up high. By the use of hanging pedals a few inches are gained.

Transmission of Driving-power.—Reverting to the ordinary type of tricycle in which the power is applied to a crank axle and transmitted thence to the main axle, there are three plans commonly in use—(1) by chains or bands: (2) by gear wheels; (3) by cranks and coupling-rods.

Driving-Chains. These are the most popular means of transmitting power, as they offer the greatest facilities for gearing up or down. The Morgan and the Abingdon chain were figured and described.

Driving-Bands.—Steel bands, plain or perforated, have been used with some success. The Otto bicycle is the only machine in which plain bands are used for driving. The power spent in continuous flexure of the bands outweighs, in the author's opinion, any other advantages they may possess.

Gear-Wheels.—In this system an intermediate wheel gears with those on each axle; but as the wear cannot be taken up without destroying the pitch, the plan is hardly satisfactory. Rollers are occasionally fitted over the teeth of the intermediate wheel.

Coupling-Rods.—Coupling-rods are used on a few machines; with the exception that they will not permit of gearing up or down and that they cannot be used with differential gear, they give very good results.

Another method due to Mr. Boys, in which eccentrics and steel bands are employed, was also referred to.

(*To be continued.*)

NOTES

Dr. Asa Gray was presented, on November 18, being the seventy-fifth anniversary of his birth, with a silver vase, by the botanists of America. It is described by *Science* as being about eleven inches high, and is appropriately decorated with those plants which are distinctively American, and which are most closely associated with Dr. Gray. The place of honour on one side is held by *Grayia polygaloides*, and on the other by *Shortia galacifolia*. Among others, *Aster Bigelovii, Solidago serotina, Lilium Grayi, Centaurea americana, Notholæna Grayi*, and *Rudbeckia speciosa*, are prominent. The workmanship is described as highly artistic, as well as remarkably accurate. The vase stands on a low ebony pedestal, which is surrounded by a silver hoop, bearing the inscription:—

1810—November Eighteenth—1885
ASA GRAY
In token of the universal esteem
of American botanists.

The greetings by card and letter of the one hundred and eighty contributors were presented on a plain but elegant silver tray. They contained the warmest expressions of esteem and gratitude.

As we intimated last week, the death took place in Paris, on the 30th ult., of M. Bouley, President of the Academy of Sciences, after a long and painful illness. Although, says the *Revue Scientifique*, he did little original work in science, he exercised a wide influence on its general progress as well as on scientific education. He did much to raise in public consideration the art and science of veterinary surgery and medicine. Latterly, he became the ardent apostle of the teachings and discoveries of M. Pasteur, and to this work he devoted his lucid and vigorous eloquence. His books on experimental disease and on contagion are models of scientific style, as his lectures at the Museum were models of instruction.

The death is announced, at the age of eighty years, of Prof. Giuseppe Ponzi, the Italian geologist.

The fifth edition of the "Admiralty Manual of Scientific Inquiry" is now being prepared for press, under the editorship of Prof. Robert S. Ball, F.R.S., Royal Astronomer of Ireland The following is a list of the articles, with the names of the authors or revisers:—Astronomy, by Sir G. B. Airy, K.C.B., F.R.S.; Hydrography, by Capt. W. J. L. Wharton, R.N., Hydrographer of the Admiralty; Tides, by Prof. G. H. Darwin, F.R.S.,; Terrestrial Magnetism, by Prof. G. F. Fitzgerald, F.R.S.; Meteorology, by Robert H. Scott, F.R.S.; Geography, by Sir J. H. Lefroy, F.R.S.; Statistics, by Prof. C. F. Bastable, M.A.; Medical Statistics, by W. Aitken, M.D.; Ethnology, by E. B. Tylor, F.R.S.; Geology, by Prof. Archibald Geikie, F.R.S.; Mineralogy, by Prof. W. J. Sollas, D.Sc.; Earthquakes, by Thomas Gray; Zoology, by Prof. H. N. Moseley, F.R.S.; Botany, by Sir J. D. Hooker, K.C.S.I., F.R.S.

Now that M. de Lacase-Duthiers has completed his arrangements for the marine laboratories at Banyuls and Roscoff, his friends and admirers have deemed the moment a suitable one for manifesting their sense of the value of his services to the study of zoology in France, and to zoologists all over the world, and it is hoped that all those who are connected, either by their studies or their sympathies, with the zoological school founded and directed by him, will join in the work. The proposal is to have his portrait etched by one of the best French artists, and to give a copy to each subscriber of ten francs or more. The number of copies will be strictly limited to the number of subscribers. The Universities or schools of Athens, Paris, Caen, Geneva, Liége, Cairo, Edinburgh, Clermont, Besançon, Lyons, and Poitiers are represented on the Committee. Subscriptions may be sent, before December 16, to M. J. Joyeux-Laffuie, of the Faculty of Sciences, Besançon, or, in this country, to Prof. Geddes, 81A, Princes Street, Edinburgh.

The new balloon constructed by the Meudon aëronauts, will be directed by a steam-engine, as advocated by M. Henry Giffard. Electricity will be quite given up, owing to its want of power for continuous action. From the reports to be published in the next number of the *Comptes rendus*, it appears that a velocity of six metres per second was obtained.

The Tokio Correspondent of the *Times* describes a strange linguistic revolution which is coming over Japan. Hitherto the Japanese language has been written by Chinese ideographs, or pictorial symbols, of which many thousands had to be learned by every youth. There were also two syllabaries or alphabets which were used by the common people, but no one could enter on the path of knowledge without first acquiring a knowledge of the Chinese characters, "a task which not only needed a very heavy expenditure of time, but was also calculated to stimulate the memory in an abnormal degree at the cost of other not less important mental faculties." Moreover, with the new science from the west before them, Japanese youth "could hardly afford to spend years and warp their brains in learning the single accomplishment of writing thoroughly their own tongue." A movement, which appears to be as national as such a movement could be, has now been set on foot to discard all existing methods of writing Japanese in favour of Roman letters. A society called the Roman Alphabet Association has been founded for the purpose of disseminating knowledge on this subject and of providing a uniform method of transliteration. It now consists of nearly 6000 of the leading men in the governing, educated, and literary classes. Stupendous as this change may seem to us, there is really no reason why it should not successfully be carried out. It meets in Japan a crying evil, which stunts the mental growth of its youth, places a barrier between them and the science and discoveries of the age, and which haunts and embarrasses them in their subsequent studies unless they acquire a foreign language at once in order to get rid of this incubus. Besides, the Japanese language is now written in borrowed symbols; Chinese characters are as alien to it as Roman letters; but the former have been in use a thousand years, and if the Japanese can now succeed in getting rid of them they will have accomplished a revolution more marvellous and not less beneficent than any they have passed through in the last seventeen years.

We have received from Mr. Twining a pamphlet, of which he is the author, on "Science for the Middle and Upper Classes," which is intended for the consideration of those interested in educational progress (London: J. J. Griffin and Sons, 22, Garrick Street). He first deals with the chief purposes of scientific instruction, which he classes under the heads "bionomic" ("bionomy" being his convenient expression for the science of daily life) "intellectual," "technical," and "professorial." He then draws up and discusses a scheme of scientific teaching extending over the whole school period of a boy. There are, in addition, numerous observations on the teaching f various branches of science. Mr. Twining's pamphlet is herefore essentially for the teacher, and, as he has evidently devoted great attention to the subject, and is himself engaged in the practical work of education, his pamphlet should prove useful and suggestive.

In the *Revue Scientifique* M. de Lacaze-Duthiers describes a curious phenomenon which he has observed in a parrot belonging to him. The bird is very intelligent, having an excellent memory for his friends and his enemies; of this trait and other marks of intelligence the writer gives several instances. The point of the article, however, is this:—The parrot has manifested an extraordinary affection for a little boy named Raymond, but usually called by the Southern diminutive, "Momon." The child called M. Duthiers's attention one day to the fact that, whenever he played with the bird, the eyes of the latter became quite red. When the boy went away, the parrot would call out his name perpetually; when he returned, it would walk to and fro on its perch, exhibiting every mark of extreme pleasure; and the eyes invariably grew red. At these times it would allow no one else, however friendly, to approach the cage; it would not eat its most favourite food. When the boy hid himself for a moment, the eyes became yellow, but suddenly reddened again when he reappeared. This phenomenon was observed only with this particular child, and with no one else. When the boy went to school, or when the bird was brought to Paris from the country, it ceased completely. An examination of the bird's eye showed that the pupil is large, and usually dilated. The iris is only represented by a circular yellow band, bordered externally by a bright red strip. The pupils of parrots are known to be very mobile. When the bird manifests joy, it contracts the iris *voluntarily*, the yellow disappears, and the red strip occupies its place, spreading itself out all over the surface of the back of the anterior chamber of the eye, giving the striking red tint observed first by the child. Here, then, is a bird, intelligent, and full of affection for a particular person, manifesting its joy by the contraction of its pupils, and thus voluntarily modifying the colour of its eyes. When violently angry, some streaks of red dart across the eye, but they never remain as in the other case. It is curious, concludes M. Duthiers, to see a phenomenon, regarded as independent of the will in the superior animals, thus found in association with feelings and acts which determine joy or anger, and which is apparently as voluntary as the movements of the feathers and all other essentially voluntary acts.

Herr Stejneger continues to supply *Naturen* with interesting reports of his recent boating expeditions in Behring's Sea. In the latest of these we find much valuable information in regard to important changes to which the fauna of these regions is being subjected through the reckless destruction of some animals, and the rapid spread of others by the introduction, through the agency of man, of previously unknown species. Thus, while there were upwards of 5000 sea-otters (*Latax lutris*) killed on the Prybilof Islands in the first year of their occupation, after six years not one of these animals was to be found on the spot, nor have they ever reappeared there during the century that has elapsed since then. At Mednij, on the other hand, where otter-hunting is conducted with moderation and under legal restrictions, there is no marked diminution in the numbers of these animals, and there is at present every prospect that the supply of skins will continue to yield a fair source of wealth to the inhabitants. The killing of foxes is similarly controlled in some districts, where the natives refuse to allow Master Reynard to be hunted, excepting in the last three months of every second year, during which time no one is allowed to fire a gun, or drive with dogs along the coast, lest the sound of the shots and the barking should interfere with the success of the licensed fox-hunters, who on these occasions occupy the earth huts specially set apart for their use in the several districts.

Owing to the moderation shown in its pursuit, the Behring Straits fox, known as the blue fox, from the colour of its skin in winter, seems for the present to be in no danger of dying out, several of these animals being generally visible on the strand of every little bay, where they arrest attention by their loud, howling bark, which is often continued hour after hour through the night. Till recently they might have been regarded as the only terrestrial quadrupeds on Behring's Island; but in the present day the brown field-mouse (*Arvicola rutila*), which was unknown eleven years ago, has made good its footing on the island, swarming over every district, from the heights of the fjelds to the flats of the tundra, and from the interior to the most exposed rocks along the coasts. Till 1874 the mouse family was unknown on the island, the oldest inhabitants never having seen one of the species prior to that date, when the gray mouse (*Mus musculus*) unexpectedly made its appearance, having probably been introduced in a cargo of flour from San Francisco. The advent of these pests was followed a few years later by that of the more destructive brown field-mouse, a phenomenon which the simple natives explain to their own satisfaction by assuming that the shorter-tailed rodent is a descendant of the long-tailed gray mouse, which had thus changed its colour and appearance the better to adapt itself to its novel terrestrial life. Mednij is still free from these undesirable immigrants, but the fact is not regarded in the light of a happy exemption by the inhabitants, who, considering this short-tailed little quadruped as specially adapted for a domestic pet, petitioned the authorities to provide them with an adequate supply. Their eager desire for the acquisition of rodents has, fortunately for them, been only so far complied with that, in place of the coveted voles, a few rabbits were sent to the island.

Naturen draws attention to the notices to be found among Scandinavian authorities of the observation in past times of the same after-glow in the sky which has in recent years been made the subject of so much discussion. Thus we learn from a Danish journal that the glow in the skies observed in 1636 by seamen navigating the northern seas was ascribed at the time to the eruption of Hecla which occurred in that year. From the same source we derive a circumstantial notice of a similar phenomenon observed in Copenhagen on May 29, 1783, which continued, with slight variations, till the close of the following September. In the months intervening between these dates the heavens were illumined by a constant red glow, although the sun appeared by day like a faint disk, and was wholly invisible at its rising and setting. The air is said to have remained unaffected by cold or heat, rain, or dry weather. The superstitious were not slow in interpreting these unwonted phenomena to portend great national troubles, while some persons even regarded them as the immediate forerunners of the end of the world. After a time, however, news reached Denmark that there had been an unusually violent eruption of the Skapta Jökul in the previous spring, and thenceforth a conjecture was advanced that the remarkable redness of the sky might, as in 1636, be connected with the great outbreak of volcanic energy in Iceland.

A NEW discovery of apatite is reported from Stavanger, where, about 30 kilometres east-south-east of the spot at which Herr Enoksen found this mineral last summer, its presence has again been detected in a granitic formation near Lerwik. Here it appears in a finely granulated form intermixed with nickel and magnetic iron pyrites, the masses varying in size from 18 to 38 inches in diameter, and lying detached in a dark deposit, which is believed to be mica diorite. In the matter of mineral finds of real value the Stavanger district has been specially favoured in recent times, and we are glad to learn that the sanguine expectations excited by the accidental discovery in 1881 of a zinc mine near the head of the Sövdefjord, have been fully justified by the result of the yields. On a more careful examination it has been ascertained that these mineral deposits extend horizontally for a distance of 80 metres, while they have been traced to a depth of 60 metres. The ore is blende, or sulphide of zinc, which appears in flat perpendicular masses, from 50 centimetres to 4 metres in thickness.

THE Russian Government has assigned the sum of 255,500 roubles to be expended during the year 1886 in new geodetical surveys in Ferghana, the territories bordering on China, the Usuri district, the Transcaspian province, and Finland.

THE Government of Tasmania are making arrangements upon a large scale for naturalising lobsters, crabs, turbot, brill, and other European fishes in the waters of that country. The various consignments will be shipped at Plymouth, and transported through the medium of the steamship companies trading between London and Hobart. An exhaustive report has been published by the Government of Tasmania, setting forth the objects in view, and giving suggestions for carrying them into effect. The report adds that while the achievement of the acclimatisation of European fishes would lay the foundation of new and very valuable fishing industries in Tasmania, it might also prove a highly remunerative commercial enterprise to the shipping firms under whose auspices the operations wil be conducted. Applications have been made in various quarterl for supplies of fish, which have been satisfactorily responded to. Special tanks are being prepared, as well as apparatus, in order to provide for the necessities of the fish *en route* which, it is anticipated, can be transmitted with little difficulty. The success that has hitherto attended the acclimatisation of certain European fishes in New Zealand has had the effect of inspiring the Government of that colony with considerable enterprise in developing their fisheries. They are now about to collect the ova of *Salmonidæ* from English waters in large numbers through the instrumentality of the National Fish-Culture Association, and other bodies, with a view to rearing the fry in New Zealand. A shipment of eggs will also shortly be sent to Australia, where great success has attended the introduction of our fishes, except in a few instances, when failure resulted more from misadventure than from the impracticability of the attempt.

A DREADFUL earthquake occurred in Algeria on the night of December 3–4. The centre of commotion seems to have been located near M'sila, a small town in the interior. The place was disturbed a second time on the following morning. The last commotion was more destructive than the first. The number of victims is estimated at one hundred. The commotion was felt at Setif and at Moscara, whose distance is about 400 kilometres. Their direction was east to west. The difference was 7 seconds at Setif, and 8½ at Moscara, where three different shocks were felt. The commotion was noted also in Algiers without any accident being recorded. According to latest news, the series of earthquakes is continuing with unabated energy. We learn that on the night of the 4th to the 5th inst. a port of Bousaada, a town of 6000 inhabitants, almost exclusively Arabs, has been partially destroyed. The church and seventy-one houses have been demolished; the victims are not numerous, all the population having encamped in the fields. This town is the centre of a large market, celebrated in all the south of the province of Algiers, 254 kilometres south of the city. Another telegram states that other commotions were felt on the 6th at M'sila for the second time. These last shocks are reported very heavy; time, 2 and 4 p.m. The time appears to have been the same at M'sila.

OUR Paris correspondent writes that in relation to the balloon which is said to have been seen over Bermuda in September, no ascent took place in France which can account for it.

WE learn with regret that M. de Mortillet, the sub-Director of the Prehistoric Museum at St. Germain, has been obliged to resign owing to his election to the French Lower House as a Member for Versailles. A competition has been opened to fill up the post vacated by his resignation. The Society of Anthropology and similar scientific institutions have signed a recommendation to the Minister of Public Instruction on behalf of M. Adrien de Mortillet, who has been associated with his father in the publication of his recent works on prehistoric science.

THE additions to the Zoological Society's Gardens during the past week include a Sly Silurus (*Silurus glanis*), European, a Thunder-fish (*Misgurnus fossilis*), a Ground Loach (*Cobitis tænia*) from Danzig; a Barbel (*Barbus vulgaris*), a River Bullhead (*Cottus gobio*) from British fresh waters, presented by Mr. Alban Doran, F.R.C.S.; one hundred Golden Carp (*Carassius auratus*) from Spain, presented by Messrs. Paul and Co.; a Black-shouldered Kite (*Elanus cæruleus*) from Africa, received in exchange.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *DECEMBER* 13-19

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 13

Sun rises, 8h. 0m.; souths, 11h. 54m. 33·8s.; sets, 15h. 49m.; decl. on meridian, 23° 12′ S.: Sidereal Time at Sunset, 21h. 19m.

Moon (at First Quarter on Dec. 14) rises, 11h. 48m.; souths, 17h. 16m.; sets, 22h. 53m.; decl. on meridian, 6° 51′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	8 53	12 48	16 43	23 8 S.
Venus	11 4	15 18	19 32	20 5 S.
Mars	23 0*	5 43	12 26	7 52 N.
Jupiter	0 45	6 47	12 49	0 23 S.
Saturn	16 49*	0 58	9 7	22 27 N.

* Indicates that the rising is that of the preceding day.

Occultations of Stars by the Moon

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
17	μ Piscium	5	1 47	2 40	159 308
18	B.A.C. 741	6½	3 9	3 23	66 34
18	B.A.C. 987	6½	23 2	0 2†	162 284

† Occurs on the following day.

Phenomena of Jupiter's Satellites

Dec.	h. m.		Dec.	h. m.	
13	7 14	I. tr. ing.	16	1 19	I. occ. reap.
14	3 24	I. ecl. disap.	17	7 2	II. ecl. disap.
14	6 51	I. occ. reap.	18	4 36	IV. ecl. disap.
15	1 43	I. tr. ing.	18	7 23	IV. ecl. reap.
15	2 29	III. occ. reap.	19	4 36	II. tr. ing.
15	3 59	I. tr. egr.	19	7 24	II. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Dec.	h.	
17	7	Mercury at least distance from the Sun.
19	4	Mercury in inferior conjunction with the Sun.

Variable Stars

Star	R.A. h. m. s.	Decl. ° ′		d.	h. m.	
R Vulpeculæ	20 59 17	23 22·0 N.	Dec.	15,		*m*
δ Cephei	22 24 54	57 49·6 N.	,,	16,	4	*M*
			,,	17,	18	*m*
R Cassiopeiæ	23 52 34	50 44·9 N.	,,	15,		*m*
U Cephei	0 52 8	81 15·3 N.	,,	14,	2 26	*m*
			,,	19,	2 5	*m*
T Monocerotis	6 19 1	7 8·9 N.	,,	17,	22	*M*
ζ Geminorum	6 57 17	20 44·3 N.	,,	18,	17	*m*
U Monocerotis	7 25 19	9 32·2 S.	,,	17,		*M*
T Geminorum	7 42 24	24 1·2 N.	,,	17,		*M*
W Virginis	13 20 6	2 46·9 S.	,,	18,	2	*m*
δ Libræ	14 54 50	8 3·7 S.	,,	15,	19 31	*m*
			,,	18,	3 22	*m*
U Coronæ	15 13 30	32 4·1 N.	,,	19,	21 25	*m*

M signifies maximum; *m* minimum.

Meteor Showers

A shower from the constellation of the Quadrant, radiant, R.A. 220°, Decl. 53° N., may be looked for throughout the week, after the moon has set.

A small shower with radiant in the constellation of the Lynx, R.A. 108°, Decl. 63° N., has been observed by Schmidt and Zezioli during this week of the year.

Stars with Remarkable Spectra

V Cygni R.A. 20h. 37m. 36s., Decl. 47° 43′·8 N., variable. Secchi's fourth type. The blue end is either wanting or extremely faint. The two dark bands usually seen in the orange in stars of this type seem absent, but the dark band in the yellow is very pronounced.

	R.A. h. m. s.	Decl. ° ′		
Birmm. 566	20 32 50	17 52·0 N.	Mag. 7·0	Three well-marked examples of the third type
Birmm. 569	20 40 13	17 40·5 N.	Mag. 6·8	
L.L. 40182	20 43 24	0 59·2 S.	Mag. 6·8	
ρ Persei	2 57 48	38 23·8 N.	Variable	Three typical representatives of the third class
α Orionis	5 48 58	7 22·9 N.	Variable	
π Aurigæ	5 51 24	45 55·5 N.	Mag. 4·8	

α Orionis and ρ Persei show many fine metallic lines beside the system of dark bands, shading off towards the red, which forms the characteristic of the third type of stellar spectrum. These brighter stars should be by all means examined with the fainter stars of the same type that the observer may become perfectly familiar with the characters and positions of the principal bands.

The *Dun Echt Circular*, No. 101, issued on December 5, from Lord Crawford's Observatory, says that the announcement has been received by Harvard College Observatory, from Dr. Lewis Swift, Director of the Warner Observatory, of the discovery of a comet by Barnard.

1885	Greenwich M.T. h. m.	R.A. h. m.	Decl. ° ′
Dec. 3	15 7.2	4 21·9	N. 4 45

Daily motion 35′ towards the north preceding.

The above message was forwarded by Prof. Krueger, of Kiel.

EXPLOSIONS IN COAL MINES[1]

II.

THE superficial observer, in noting the real progress made during the last few years in the facility and success with which the electric light has been utilised in a remarkable variety of directions, might have been pardonably led to the conclusion that there existed no very great difficulties in the way of at once presenting the miner with an electric light in almost as portable a form as a safety lamp—incomparably safer than the best of these—and capable of affording a much superior light for the entire duration of his longest working hours underground. A little inquiry into the subject demonstrated to the Royal Commission that such a conclusion would be at least very premature, and that, although the subject was one most worthy of patient pursuit, the attainment of really useful results was beset with formidable difficulties. It is one thing to announce in oracular fashion, as the *Times* did, in a leading article last June, "that collieries ought to be lighted in a way to dispense with safety lamps," and "that electricity is the one illuminating medium which can supply the light which miners want, without the flame which endangers them." It is quite another thing to apply the electric light with safety, even along main roadways, in mines in which fire-damp is prevalent. The writer of those lines would have been less confident in his assertions had he sought sufficient information to teach him that the fracture of a glow-lamp, or the rupture of a conducting wire in a mine, might be as much fraught with danger as the injury of a safety lamp or the lighting of a pipe. Had he, moreover, but learned by simple inquiry what progress had been made by patient workers (at the time he was inspired thus to write), towards setting aside those sources of danger and providing the miner with a portable and efficient self-contained lamp, he would certainly have hesitated to assert that "no proper zeal has been brought to bear upon the conquest of difficulties" in the application of electric lighting in mines, or to sneer at "the scientific brains, whom the public may encourage, though it cannot compel, to exert themselves as keenly for the

[1] Address of Sir Frederick Abel, Chairman of Council of the Society of Arts, delivered at the opening meeting, Nov. 18, 1885.—(Abstract by the Author.) Continued from p. 112.

illumination of a murky, dirty coal-pit, as in the transformation of a plot of ground in South Kensington into fairyland."

Attempts have been made in several of the mining districts to apply electricity to underground illumination; so far as distribution of the light in main roads is concerned, no great progress has been made, though there is now no reason why glow-lamps, protected after the manner in use at our Government Gunpowder Works (as shown in the recent Exhibition), should not be distributed to considerable distances along such portions of a mine. At Risca Colliery, in Monmouthshire, at Harris's Navigation Colliery, near Pontypridd, and at Earnock Colliery, at Hamilton, N.B., a commencement has already been made in this direction with satisfactory results. If, however, the miner is to have an electric lamp for lighting up drifts and working places, it must be supplied to him in a self-contained and really portable form, with absolute isolation of the glow-lamp from the surrounding atmosphere, and with a store of power sufficient to maintain an efficient light for ten or twelve hours.

The considerable improvements which have of late been effected in accumulators, and the advance which has also been made in the construction of constant primary batteries, have led to very important progress toward the attainment of these essentials. Mr. J. Wilson Swan, universally celebrated for his achievements in the matter of glow-lamps, has patiently pursued the subject, and has not long since succeeded in producing a lamp which, with its small storage battery, weighs little more than 8 lb., and which will furnish a light equal to from two to four times that given by the better forms of safety lamp for a duration of ten or twelve hours. Mr. Swan is sanguine that he will ere long be able to effect an important reduction in the weight and bulk of the lamp, and he is not less hopeful of elaborating a primary battery similar in portability and light-giving power, the substitution of which, if successful, for the accumulator would have the advantage of dispensing with the necessity for providing dynamo-electric machines and power for charging the storage cells. Other workers besides Mr. Swan, such as Mr. Coad and M. Trouvé, have been applying small primary batteries to the production of miners' lamps with some promise of success, although as yet the results furnished do not bear comparison with those obtained by Mr. Swan with the storage battery. Those who have spent any length of time under ground, especially in the very low workings which abound in coal mines, and at the high temperature which often prevails in the workings of deep mines, will have experienced the fact that any incumbrance may sometimes become very burdensome, and can well understand, therefore, that the weight and size of even the lightest form of battery with which an efficient light could be maintained for a sufficient length of time, may prove grave obstacles to its extensive employment. Moreover, as the electric light can afford no indication of the condition of the atmosphere in a mine-working, its employment may not allow of the safety lamp or some other testing appliance being dispensed with. But, even if used only as an auxiliary means of illumination in working places, such lights as those which Swan and others will supply, will prove very valuable, and especially so for exploring purposes, after accidents due to outbursts of gas, when the best safety lamps may be of little use, even if they continue to burn. Such electric lamps must indeed become formidable competitors of the Fleuss lamp (included in the recent Exhibition), which has, in conjunction with the portable apparatus for the supply of respirable air to explorers, already performed important service in rendering access to mine-workings possible where an ordinary lamp could not burn, and where the atmosphere was too foul to support life for any time.

The sudden escape into a mine-working of a very large volume of fire-damp, the accumulating pressure of which has at length overcome the resistance opposed to it, either by the coal or by the stone which forms the floor or the roof of the mine, and the outrush of which is sometimes accompanied by the ejection of very large quantities of disintegrated mineral, constitutes the most formidable danger connected with this associate of coal, because little or no warning is received of its occurrence, and because the volume of gas suddenly liberated is often so considerable that the most powerful ventilating currents are for a time inoperative, while their very action may be to distribute gas rapidly in the form of an explosive mixture with air, to distant parts of the mine-workings. The volume of gas suddenly set free varies very greatly: sometimes it is so considerable that, even with very powerful ventilation, the workings have not been restored to a safe condition for work, in regard to comparative freedom from fire-damp, until several days after the occurrence of the outburst.

That these sudden emissions of gas have been intimately connected with some of the most appalling disasters which have occurred in coal mines appears beyond question, and there is equally little room for doubt that the firing of shots, or use of gunpowder for blasting coal or stones in mines, has been, in many cases, intimately connected with those disasters.

The occurrence of a sudden outburst of gas is, however, not essential to the production of disastrous results by the firing of powder or other explosives in coal mines. The flame developed by the firing of a powder-shot may, without any favouring circumstances, be projected to a considerable distance beyond the face of the coal or stone in which it is fired, if, as is frequently the case, the force is insufficient to accomplish the fracture of the bore-hole in which the charge of explosive is confined, and the highly heated products of the explosion are entirely projected from the hole, as if the shot had been fired from a gun. Experiments upon an extensive scale made, on this head, by the Commission, have shown that the flame from a so-called *blown-out* shot may be projected to distances of thirty or thirty-five feet, in galleries similar to mine-workings or drifts, and if, as is frequently the case, the small debris of coal, which lies ready to hand in the working places is used to tamp the charge with, the volume of flame from a blown-out powder-shot is very greatly increased in length and volume, and may therefore easily extend to goaves, old working places, or cavities where a fire-damp- and air-mixture may be lurking. This is, however, by no means the only, or even the most prominent, danger which may attend the occurrence of a blown-out shot in even the best ventilated coal mine, quite independently of the possibility of a sudden release of a considerable volume of fire-damp during, and consequent upon, blasting. But before referring to what now appears to be well established as the chief general source of danger attending the use of explosives in coal mines, I must touch briefly upon the means available for searching for fire-damp, and for inspecting the workings of a mine, to ascertain that all is safe before men descend to work, or before shots are fired.

The first effect of introducing a Davy or other safety lamp into an atmosphere containing small proportions of fire-damp is to cause the flame to elongate, the extremity becoming narrow and more pointed as the proportion of fire-damp increases; when the latter approaches a porportion which produces with air an inflammable, and ultimately an explosive, mixture, a pale blue halo or cap is perceptible over the flame, and this increases with an increase in the proportion of gas, until the cage or gauze of the lamp is filled with flame. A Davy lamp of small proportions is generally preferred by the overmen or inspectors for gas-testing purposes; the flame is always reduced to small dimensions, so that slight alterations in size or form may be more readily observed. An experienced operator may identify so large a quantity as 2 per cent. of gas in the air of a mine, but even this is very doubtful, except in the case of exceedingly expert observers, who may perhaps succeed in thus detecting the presence of 1·5 per cent. of fire-damp.

It has, however, now been conclusively demonstrated to be of the greatest importance that responsible persons in coal mines should be furnished with reliable means for expeditiously detecting, without the exercise of any very special skill, smaller quantities of fire-damp than it is possible to identify with certainty, even by the exercise of great skill in the use of a safety lamp. Hence much interest and moment attach to the efforts which have been made from time to time by scientific men to devise sensitive and reliable fire-damp indicators. The late Mr. Ansell applied in several very ingenious ways some results of Prof. Graham's classical researches on the diffusion of gases to the construction of sensitive fire-damp detectors, which, however, did not justify the confidence at first placed in them. The same principles have since been applied, but apparently with no greater success, by several foreign inventors of so-called *Grisoumètres.* The late Dr. Angus Smith and Prof. George Forbes have proposed to detect and estimate the quantity of fire-damp in the air of a mine by ingenious applications of other important principles in physical science, and the acoustic indicator, lately exhibited by Mr. Blaikley, is a very pretty application of the principle utilised in a different way by Prof. Forbes. Various forms of eudiometrical apparatus have been constructed with the same object: the variations in the density of air due to the presence of different proportions of fire-damp have been made the basis of other gas-indicating apparatus; a test-lamp has been constructed to furnish a flame when burning alcohol, which is much more sensitive than the oil flame of an ordinary safety lamp; and an electro-photometric test apparatus has been devised by Mr. E. H. Liveing, which appears to have been the most thoroughly practical form of gas-indicator shown at the recent Exhibition.

The importance of being able to recognise very small proportions of fire-damp in air has become specially evident, since the fact has become thoroughly established, by recent careful and comprehensive investigation, that when fire-damp is present in the atmosphere of a mine, in proportions greatly below those necessary to produce a feebly explosive, or even barely inflammable mixture, it may yet constitute a most formidable source of danger, by its co-operation with the dust which exists, in more or less abundance, in every mine-working.

The fact that coal-dust adds considerably to the disastrous effects of fire-damp explosions, was noticed already more than 80 years ago; but Faraday and Lyell were the first to demonstrate, forty years ago, how important a part might be played by coal-dust, in aggravating and extending the destructive effects of fire-damp explosions. When investigating a serious explosion which occurred in the Haswell Colliery in 1844, they observed many signs of the coal-dust being partly burned, and partly subjected to a charring or coking action, by the fire-damp explosion. Their lucid published account of the evidence that coal-dust may play an important part in the effects produced by mine-explosions covers much of the ground gone over by recent workers and writers on the subject, and affords a curious illustration of the ease with which the work of the most illustrious men may be overlooked or forgotten, even by those who should be specially interested in informing themselves of the existing state of knowledge on the subject. Thus, several well-known French mining engineers published, many years after Faraday and Lyell's work, observations, as new, which were simply confirmatory of those philosophers' original statements and conclusions.

Messrs. Galloway and Friere Marreco, but especially the former, have added importantly to our knowledge of the probable behaviour of dust in mines on the occasion of explosions. Mr. Galloway, who performed experiments upon a considerably larger scale than had previously been the case, was certainly the first to enunciate the conclusion that a small proportion of fire-damp is essential to impart to a mixture of air and coal-dust the power of propagating flame, though he afterwards concluded that fire-damp is altogether unnecessary for the conveyance of flame, with explosive effects, by a mixture of dry coal-dust and air.

The more recent results of other workers in this direction have, however, conclusively demonstrated that while some very highly inflammable coal-dusts may, when raised and mixed with the air by the force of a blown-out shot, become inflamed, and carry flame to considerable distances, with a rapidity and violence of action similar to that of a fire-damp explosion, the extent to which flame is propagated, by most descriptions of coal-dust, in the complete absence of fire-damp, is very limited.

In a series of experiments which, after the calamitous accident in Seaham Colliery in the autumn of 1880, I was requested by the present Home Secretary to carry out with coal-dusts, it was conclusively established that the proportion of fire-damp required to be present in the air of a mine, to bring dust readily into operation as an explosive agent, when thickly suspended in the air, may be even decidedly below the smallest amount which a practised eye can detect by means of a Davy lamp. Various other points of interest were established by this series of experiments.

The more extensive experiments subsequently made by the Commission, in large mine galleries, demonstrated that with a very highly inflammable dust suspended in the air in which no trace of hydrocarbon gas was present, a blown-out shot could produce ignitions which would extend as far as the mixture of air with sufficient dust to maintain flame extended.

Important experiments upon a very large scale, which have recently been carried out by the Prussian Fire-damp Commission, at Neunkirchen, in the Saarbrücken district (see NATURE, vol. xxxi. p. 12, and vol. xxxii. p. 55), have thoroughly confirmed and also considerably extended these results.

It appears now to be well established that the considerable volume of flame and rush of gas produced by a blown-out shot is indispensable to the attainment with certainty of any of the dangerous effects of coal-dust. Inasmuch, however, as blown-out shot are of very common occurrence in blasting operations, it is evident that in dusty mines there is a frequent liability to the production of a more or less extensive ignition or explosion of coal-dust, at any rate when even only very small proportions of fire-damp exist in the air of the mine. It will be seen, therefore, that it needs not a sudden outburst or accidental liberation of fire-damp in considerable quantities to cause the flame which may be projected into the air by the firing of a powder-shot to bring about extensive explosions, or ignitions, spreading over large areas, and possibly communicating to distant accumulations of explosive mixtures of gas and air in old workings.

These most serious dangers, arising chiefly from the use of powder in coal mines, have received the anxious attention of the Commissioners, who have, in the first place, considered how far it might be practicable to prescribe effectual means for removing or counteracting the elements of danger presented by the existence of dust accumulations in mines where it may be impossible to guard against the distribution of small proportions of fire-damp through the air.

The possible substitution for gunpowder of other explosive agents which may be applicable to the kind of work performed by it in coal-mines, has naturally also received much attention. A reduction in the volume of flame produced by gunpowder when used as a blasting agent has been effected by modifications in its composition, but the best result attained until recently in this direction had not materially reduced the danger of using powder in the ordinary manner. Some promising results are, however, said to have been quite lately attained in Germany with a special powder produced by the original maker of the now celebrated cocoa powder, the publication of which is looked for with much interest.

Special forms of gun-cotton were prepared for use in coal in the early days of the improvements made in its preparation; but the large proportion of the inflammable and poisonous gas, carbonic oxide, which its explosion furnishes, prohibits its employment in this direction, even in the form of preparations coming under the head of *nitrated gun-cotton*, which yields comparatively small proportions of carbonic oxide.

Nitro-glycerine contains actually more oxygen than required for the complete burning of its constituents, carbon and hydrogen, and hence its detonation in the open air is attended only by the appearance of a lightning-like flash of light. When diluted with an inert non-combustible material, as in dynamite, its detonation raises to a high red heat the particles of mineral matter with which it is mixed, many of which are, therefore, projected in a glowing state, like a shower of sparks, if the dynamite be fired in a strong shot-hole. Even with Nobel's blasting gelatine, the latest and most powerful explosive, a blown-out shot may be attended by the projection of some glowing particles, either of the tamping or detached from the blast-hole.

The Commissioners have satisfied themselves by many experiments that an explosive mixture of gas and air may be exploded by the projection into it of such sparks, and that they may even occasionally produce ignition, when projected into air containing only a small proportion of fire-damp, but in which coal-dust is thickly suspended.

The outline which I have given you of the dangers attending the use of explosives in coal mines, and of the apparently unsurmountable difficulties attending any attempts to approach immunity from the two great elements of danger naturally existing in a very large proportion of coal mines, namely, fire-damp and dust, will probably lead you to the conclusion that there is but one effectual method of dealing with the serious question of accidents due to explosions in coal mines, namely, that of enforcing the exclusion of the use of explosives in coal mines.

In the House of Commons debate of June, 1878, Mr. MacDonald, while acknowledging that the provisions of the Coal Mines Regulation Act of 1872, for prevention of accidents through the use of gunpowder in fiery mines, had been productive of great good, insisted that these regulations were insufficient to guard against fire-damp explosions, and referred, in illustration, to the fact that the firing of the shot itself might liberate a large quantity of gas, which no previous inspection would discover. He urged in the strongest terms that, until blasting in any fiery mine were absolutely prohibited, there must be a continual recurrence of terrible disasters; and, in the debate which followed, there was a general consensus of opinion among the speakers most competent, from personal experience, to express a decided view on the subject (such as Mr. Burt, Sir G. Elliot, and the late Mr. Knowles), that blasting should be prohibited, at any rate in fiery mines. It was admitted that the cost of working coal would be much increased by the enforcement of the suggested prohibition, and the majority of competent witnesses examined afterwards by the Royal Commission maintained that the abolition of shot-firing in coal-getting must be attended by very formidable difficulties, and must, in fact, cause the closing of many pits.

I have shown that even the comparatively very small amount of fire-damp which may, at any rate occasionally, pervade the air in portions of mine-workings where thorough ventilation is most effectually provided for, and may escape detection, suffices to determine the production of a disastrous explosion, if, under these circumstances, a blown-out shot occurs where an accumulation of dust exists; and that it is even possible, in the complete absence of fire-damp, for a blown-out shot to give rise to an explosion in a very dusty working or mine, where the coal is of a specially inflammable and sensitive character. Such being the case, the fact cannot be ignored that last year's decision of the late Home Secretary—which raised consternation in many mining districts—to prohibit the firing of shots in any colliery within a period of three months after the existence of gas had been there reported (while the workmen were in any part of the mine), is far from affording the contemplated protection against disaster resulting from the use of explosives *in the ordinary manner*.

This most grave aspect of the question has received the anxious attention of the Commissioners, who would not have considered themselves justified in relinquishing their work until they had practically investigated, as far as in their power, any measure or suggestion appearing to afford promise of aid in furnishing definite replies to the following important questions:—

(*a*) Whether sufficiently efficient substitutes for explosives exist to warrant the assertion that their abolition need not interfere very materially with the reasonably profitable working of collieries;

(*b*) Whether, therefore, it is practicable to limit their use strictly to localities where the absence of every possible risk of explosion can be demonstrated; or

(*c*) Whether any modifications in the ordinary method of using explosives in mines can be so confidently relied upon to guard against, or overcome, certain dangers attendant upon blasting operations in collieries, that it may be practicable to clearly define and lay down certain conditions which will insure the safe use of explosives, either generally, or in all but special cases, which can be precisely defined.

As regards the first question:—The power and efficiency of recently improved mechanical appliances for bringing down coal or for driving headings or crossways, warrant the sanguine expectation that compressed air and even manual power may be, at no distant day, brought to bear so advantageously in mines where fire-damp occurs, as to render it no great hardship to dispense with the use of explosives in some of the work where at present they are considered indispensable.

The considerable and very rapid increase in volume which freshly-burned quicklime sustains when slaked, led, many years ago, to attempts to apply it to the bringing down of coal; but the idea did not assume a really practical form until Messrs. Sebastian Smith and Moore worked out a simple method of applying the lime so as to insure the effective operation of the disruptive force which it is capable of exerting, and to utilise the considerable heat, developed by the union of the lime with water, in the rapid generation and super-heating of steam in somewhat considerable quantity, thus supplementing, in an important manner, the force exerted by the expansion of the lime. The public has been made familiar, in last year's and this year's Exhibitions, with the general nature of Messrs. Smith and Moore's lime cartridges. The Commissioners witnessed their performances at Shipley Collieries soon after their successful elaboration, and the results of subsequent inquiries and experiments have convinced them that, for coal-getting, the lime process can be, to a large extent, substituted for powder, and that its employment, while securing comparative immunity from danger, is unattended by any important practical difficulties.

It has received extensive trial in many of our mining districts, and also on the Continent, and has already taken firm root in some parts of Staffordshire, Yorkshire, and Derbyshire. Its elaborators do not contend that it affords the means of dispensing with the use of explosives, or of specially powerful mechanical appliances, in the removal of stone, or even in some very hard coal; but it is certain that in many collieries, where the prevalence of fire-damp renders the use of the safety lamp imperative, the replacement of shot-firing by lime-cartridges, while unattended by any increase in the cost of getting the coal, would reduce the risk of explosions to those arising from carelessness, or from what should now become the very remote contingency of the use of unsafe or defective lamps.

The idea has been entertained that, by surrounding or covering the charge of powder in a shot-hole with some material which evolves vapour of water, or carbonic acid, when exposed to sufficient heat, these would be liberated by the firing of the shot in sufficient quantity and with sufficient rapidity to extinguish flame and sparks projected by it; but the authors of such suggestions have failed to realise the fact that the exposure of these substances to heat on the firing of a shot would be almost instantaneous, and would therefore leave, at any rate, the greater proportion practically unaltered.

It was suggested by me to the Commissioners that possibly the sudden liberation of carbonic acid, confined in the liquefied state, and placed either over or under the charge in a shot-hole, might prove effective in extinguishing flame and sparks, and a number of experiments have been made in this direction, with considerable, though not complete, success.

Dr. McNab was the first to put into practical execution the idea of using water tamping, in the form of a long cylinder filled with the liquid and placed over the powder charge; with the twofold object of extinguishing the projected flame and sparks, and of diminishing, by dispersion of the water in the immediate vicinity of the shot, the persistence of the powder smoke, which is a source of much inconvenience and loss of time. While it has been demonstrated that decided economy in time does result from the more rapid clearing of the air from smoke when the water tamping is used, many careful experiments conducted for the Commission have shown that no reliance could be placed upon the extinguishing power of water, applied in the way originally suggested by Dr. McNab.

In 1879 I suggested to the Commission a plan by which possibly the more violent explosives, of the dynamite class, might be safely and efficiently applied to the getting of coal, based upon the principle of distributing the force developed by the detonation of small charges over a considerable area through the agency of a column of water, within which the detonated charge was confined. This principle, which has since received important applications in connection with military service, appeared applicable to effect a modification of the shattering action, which renders the violent explosives inapplicable to coal-getting, when used in the ordinary manner, their effects being thus assimilated to those of powder, while the sparks and highly-heated gases projected by a blown-out shot might be effectually quenched by the water which would envelope them at the instant of their projection.

Experiments carried out at Wigan in 1880, demonstrated that the coal brought down by small charges of dynamite inclosed in water compared very favourably with the best results furnished by full powder charges, and these results have been fully confirmed by trials since carried out for the Commission in South Wales. Absolute immunity from danger of the ignition of an explosive gas-mixture by a blown-out shot of dynamite or similar explosive agent was not found to be secured by this system of blasting; such was the case, however, then the blown-out shot was projected into air containing fire-damp in proportions approaching that of an explosive mixture, and in which a very inflammable coal-dust was thickly suspended. It has also been found, in the Commissioners' experiments, that the superposition of the water-tamping, according to Dr. McNab's original plan, over a dynamite charge, appears to afford security against the ignition of a dust-laden mixture of air with a somewhat considerable proportion of gas.

Even while actively engaged in the completion of their Report, the Commissioners are still pursuing this subject experimentally, with the desire of furnishing, as far as in their power, decisive and thoroughly reliable data regarding the amount of security which appears to be afforded, by these methods of working, against the most prominent and prevalent sources of danger in connection with the use of explosives in coal mines; and—while I have been engaged upon this address—a still more simple method of applying water to counteract the dangers arising from blown-out shots has suggested itself to Mr. Galloway,—preliminary experiments with which have furnished most important results.

I have now attempted to give you an outline of the progress made within the last few years towards a thorough comprehension of the nature and causes of those dangers which most prominently direct public attention to the perils of the miner's calling—and of the advances already made, and rapidly progressing, towards the provision of the miner with really safe and efficient underground illumination, with efficient substitutes for explosives for a large proportion of the work connected with coal mining, and with safe methods of using explosive agents where these cannot be dispensed with; so safe that the terrors which have attended blasting in mines may be confidently expected speedily to fade away. I venture to think it will have demonstrated that we have made most satisfactory and important progress in all of these several directions, thanks to the labours of professional associations, of scientific and practical experts, and, I think I may also say, thanks to the exertions of the Royal Commission on Accidents in Mines.

I have been led to refer more fully than I had first intended to the work performed by the Royal Commission—the results of which, in detail, will shortly be in the hands of the public—because I felt sure that the members of the Society of Arts would take a most lively and sympathetic interest in the labours of men, who have not allowed themselves to be discouraged by unjust attacks and ignorant criticism, from endeavouring to carry to a useful termination the arduous work which they cheerfully took upon themselves.

The Commissioners have been silent while hard things have been said of them; but it were idle to deny that they have acutely felt the injustice reflected upon them by some writers in the public Press who, while posing as judges or philanthropists, have not earned for themselves, by knowledge acquired, or by work performed, the right to criticism.

Thirty years' personal experience of the work of experimental Committees has taught me that *ad interim* reports are not unfrequently worse than valueless, and this would certainly have been the case had the Commissioners attempted to make any so-called progress reports, because conclusions, or suggestions, might have been put forward in them which would have had to be afterwards recalled, or incomplete data given, which might have been misleading, and, therefore, even dangerous.

As regards the question of the unsafe nature of certain so-called safety lamps, however, I have pointed out that the Commissioners, just five years ago, reported to the Home Secretary in no hesitating terms, in the belief that their statements would have been published,—and it is no fault of theirs that the public was not informed of their strongly-expressed conclusions on this subject, but has been, on the contrary, recently told in the *Times* by a well-known mining engineer that the results of the Royal Commission's labours "have not even extended to the official condemnation of the known unsafe lamps."

The daily journals have at any rate chronicled the activity of the Commission by recording the dates and *locale* of their frequent meetings,—and have been cognisant, therefore, of the fact that their place of work was easily accessible. This being so, it is somewhat matter for surprise that the writer of very condemnatory paragraphs in an editorial article, suggested by correspondence published in the *Times* last June, should not have cared, in the first instance, to inform himself, however imperfectly, of the kind of work upon which the Commission was engaged, and to take that opportunity of seeking some little correct information on the subjects with which his graphic pen was directed to deal. Had he done so, he would scarcely have instructed the public that "a huge majority of colliery accidents arise from explosions;" that "coal mines generate an explosive gas, which, when collected in a quantity, and exposed to a flame, ignites, and blows into fragments the workings in which the vapour and flame meet;" "that every coal mine has its explosive gas," or that "often the miner has opened the door of his lamp to light up the cavern, already perhaps darkening with the heaviness of a gas-laden atmosphere." I will do him the justice to believe that he would not have felt disposed, after even very brief inquiry, to indorse as "not exaggerated" the declaration of the "strenuous and benevolent correspondent," Mr. Ellis Lever, "that the delay in the issue of the Commission's Report was "to the eternal discredit of Royal Commissions."

After all, however, it rests entirely with the public Press to decide for itself whether the ends it has in view are such as to render it desirable to seek for correct information before administering public condemnation.

But, with a public official, especially when connected with the very Department of State most directly concerned in the work of the Commission, the case is very different; and it is scarcely to be credited that the gentleman intrusted with reporting to the Home Secretary upon the circumstances attending the explosion last summer, at Clifton Hall Colliery, should not have thought it worth his while to ascertain, by inquiry, which could not but have been of immediate service to him, whether the delay in the completion of the Commissioners' Report was "unaccountable."

To this Society, which has always distinguished itself by its encouragement of earnest workers, and by its just judgment of their labours, I have ventured, as one of its members, to make these comments, which could not be uttered by me in my capacity as a member of Her Majesty's Commission, whose duty it is simply to report the results of their labours when they have, to the best of their judgment, fulfilled the duties imposed upon them.

SOCIETIES AND ACADEMIES

London

Royal Society, November 19.—Abstract of "Report on a Series of Specimens of the Deposits of the Nile Delta, obtained by the recent Boring Operations." By J. W. Judd, F.R.S., Professor of Geology in the Normal School of Science and Royal School of Mines. Communicated by order of the Delta Committee.

Neither of the borings made for the Royal Society, under the superintendence of the engineers attached to the army of occupation in Egypt, appears to have reached the rocky floor of the Nile-Valley, nor do the samples examined show any indication of an approach to such floor. What were at first supposed to be pebbles in one of the samples from Tantah, prove on examination to be calcareous concretions ("race," or "kunkur"). Nevertheless, these borings appear to have reached a greater depth than all previous ones in the same district with one or two exceptions. The deepest of the three borings now reported upon have been carried to 73 and 84 feet respectively.

The samples from these borings, like those examined by Mr. Horner, show that the delta-deposits all consist of admixtures, in various proportions, of blown-sand and alluvial-mud. I can find no evidence to support the suggestion made by Sir J. W. Dawson, F.R.S., from a hasty examination of the specimens, that "at a depth of 30 or 40 feet the alluvial mud rests on desert sand;" on the contrary these borings, like those of older date, show that the deposits of the Nile Valley consist of a succession of different beds in some of which sand, and in others mud, forms the predominant constituent.

The *sands*, when separated from the mud by washing, are found to be made up of two kinds of grains, the larger being perfectly rounded and polished, while the smaller, on the contrary, are often subangular or angular.

The larger and well-rounded grains may be described as microscopic pebbles; their surfaces are most exquisitely smoothed and polished, and their forms are either globular or ellipsoidal. In size they vary greatly, being occasionally as large as a small pea. They only very occasionally exhibit traces of deposits of iron-oxides upon their surfaces.

Embedding these grains in Canada balsam, and examining them by transmitted light, with the aid of the polariscope, we are in nearly all cases enabled to determine their mineral characters. The majority of the grains consist of colourless quartz, though occasionally rose-quartz, amethystine quartz, citrine, and smoky quartz also occur. This quartz exhibits unmistakable evidence of having been derived from granitic rocks; it is constantly seen to be traversed by bands of liquid- and gas-cavities, and very frequently contains numerous black hair-like inclusions (rutile?). Much more rarely we detect grains of quartz which consist of aggregates of small crystals, and are evidently derived from metamorphic rocks. With the pure quartz grains we find also a considerable number of rounded particles of red and brown jasper and of black Lydian stone, with fragments of silicified wood.

But in addition to the different varieties of quartz, particles of felspar are found in considerable abundance among these large rounded grains. What is very remarkable about these felspar-grains is the slight traces of kaolinisation which they exhibit; they are, in fact, almost as fresh and unaltered as the grains of quartz themselves. Ordinary orthoclase and microline are abundant, while plagioclase felspar is comparatively rare. With the rounded grains of quartz and felspar, a few examples of hornblende and other minerals, including jade, also occur.

But far greater is the number of mineral species represented in the smaller subangular and angular sand-grains. In addition to the minerals already mentioned, I have recognised several varieties of mica, augite, enstatite, tourmaline, sphene, dichroite (cordierite), zircon, fluorspar, and magnetite.

The *mud* is a much more difficult material to study the mineral characters of than the sand, owing to the extreme minuteness of its particles. It is a ver striking fact, however, that kaolin, which constitutes the predominant ingredient of clays, appears to be almost absent from these Nile-muds. Chips and flakes of quartz, felspar, mica, hornblende, and other minerals, can be readily recognised, and it is often evident that the unaltered particles of such minerals make up the greater part, if not the whole mass, of the fine-grained deposits. The mineral particles are, of course, mingled with a larger or smaller proportion of organic particles. Frustules of *Diatomaceæ* occur in these muds, as was pointed out by Ehrenberg, but unless special precautions were observed in collecting the samples it would be unsafe to draw any deductions from their presence.

The striking peculiarities of these sands and muds of the Nile-Valley appear to be capable of a simple explanation. In countries where rain falls and vegetation abounds, water charged with carbonic acid is constantly tending to break up the compound silicates; the silicates of the alkalies and the alkaline earths being decomposed and their constituents removed in solution, while the silicate of alumina becomes hydrated, and is carried away in suspension by water in the form of kaolin. In this way, the felspars and nearly all other compound silicates are affected to such an extent that in most granitic and metamorphic rocks they show evidence of extensive "kaolinization," while the clays derived from them are made up for the most part of crystalline plates of kaolin. But in a rainless country, like Northern Africa, none of these agencies will operate, and the disintegration of the solid rocks is effected by mechanical means; the most potent of these mechanical agents are the heat of the sun, causing the unequal expansion of the minerals which build up the rocks, and the force of the wind, producing constant attrition of the disjoined particles.

This being the case, it will be readily understood that the coarser sand-grains will include felspar and other minerals in a nearly unaltered condition, while in countries where the chemical agents of the atmosphere come into play, such particles would be more or less completely converted into kaolin. In the same way the mud, instead of consisting of scales of kaolin originating from chemical action, will be formed of particles of the chemically unaltered minerals reduced to the finest dust by purely mechanical agencies.

The chemical analyses which have been made of these Nile muds entirely support these conclusions. Instead of containing a considerable proportion of combined water, as do all the ordinary clays, their composition is that of a mixture of anhydrous minerals.

But there is fortunately a kind of evidence, derived from chemical analysis which is of the greatest value from its bearing on the questions we are now discussing—that, namely, which is derived from a study of the composition of the Nile-waters.

It must be remembered that the Nile is a river of a very peculiar and exceptional character. The last tributary which it receives is the Atbara, which falls into it in lat. 17° 38′ N.; from that point to its mouth, in 31° 25′ N. lat., the river does not receive a single affluent; for a distance of 1400 miles it acquires no fresh supply of water except what is brought to it by superficial torrents after heavy rains in Lower Egypt. It has been clearly demonstrated that, after receiving the Atbara, the Nile undergoes a continual diminution in volume in its course through Egypt. This is no doubt in part due to percolation of the water through the delta-deposits, and in part to the water being drawn off in canals for purposes of irrigation; but a large part of this diminution in volume must certainly be ascribed to the great evaporation which must be going on from the surface of the river during the last 1400 miles of its course.

Although we shall not be able to calculate the exact loss of the Nile by evaporation in the course of 1400 miles through one of the hottest and driest regions of the globe, yet we cannot doubt that this loss is enormous. Now the effect of this constant evaporation must be to concentrate the saline matters held in solution, and we might therefore anticipate that the waters of the Nile in Lower Egypt would contain an exceptionally high percentage of saline matters in solution.

But what are the actual facts of the case?

According to the analyses of Dr. C. Meymott Tidy, the Nile contains only a little more than one-half of the proportion of soluble materials which exists in the Thames, the Lea, the Severn, or the Shannon!

A little consideration will show, however, that this startling and seemingly anomalous result is capable of simple and easy explanation. The substances dissolved in the water of rivers is of course derived from the materials composing the rocks of the river-basin, through the action of water holding carbonic acid or other acids in solution.

Hence we are led by the study of the composition of the Nile water to the same conclusion as was reached by the study of microscopical characters of the muds and sands of the delta, that while in the rainy districts of the temperate zones the disintegration of rocks is mainly effected by chemical agencies, in the rainless areas of the tropics the same work is almost exclusively effected by mechanical forces.

The products of these two kinds of action are, however, essentially different. In the former case we have formed crystals of kaolin, which constitute the basis of all the true clays, a large quantity of lime, magnesia, iron, soda, and potash salts with silica passing into solution; while, in the latter case, the several minerals of the rock are simply reduced to fragments of varying size and form, and but little matter passes into solution.

The whole of the observations described in the present report are in entire harmony with this explanation. The comparatively unaltered condition of the felspars and other complex silicates in the sands; the absence of kaolin from the muds, and the presence of the chips and flakes of the unattacked minerals in the muds; and finally the small quantity of dissolved matter in the Nile-water, in spite of the enormous concentration it must have undergone by evaporation—all point to this same conclusion.

In the estimates which have been made of the rate of subaërial denudation in different parts of the globe, it has usually been assumed that this action is similar to what is seen taking place in our own country and in North America. But the observations detailed in this report prove that in rainless tropical districts, where little or no vegetation exists, the disintegration of rocks, though not, perhaps, less rapid than in temperate climes, is different alike in its causes and in its products.

It has often been pointed out by chemical geologists that metamorphic action could not have produced many of the schists from sedimentary rocks, for the former are rich in potash, soda, and other materials which have been dissolved out from the latter during the disintegration of the rock-masses from which they were derived. The recognition of a kind of action whereby great masses of sedimentary materials can be produced, rich in those substances which are usually removed in a state of solution, is not destitute of interest at the present time, when the question of the origin of the crystalline schists is one that presses for solution.

PARIS

Academy of Sciences, November 30.—M. Jurien de la Gravière, Vice-President, in the chair.—The Vice-President announced the death of the President, M. Henri Bouley, who died on the morning of the same day. The speaker referred in warm terms to the career of M. Bouley, his entire devotion to science, and the courage with which, although suffering from a fatal disease, he continued to the last to fulfil the duties of his office.—Obituary notices of M. Bouley: by M. Hervé Mangon, in the name of the Academy of Sciences; by M. A. Milne-Edwards, in the name of the Natural History Museum; by M. A. de Quatrefages, as Vice-President of the Acclimatisation Society; and by M. Fremy, Member of the Academy.—As a mark of respect for its late President, the public meeting of the Academy was immediately adjourned.

BERLIN

Physiological Society, October 30.—Prof. Zuntz spoke on the apnœa of the fœtus and the cause of the first respiration, setting forth the present state of the question, and then passing to consider the assertion of Prof. Preyer, who, by experiments on rabbits and guinea-pigs, sought to prove that it was not the change in the gas of the blood which was the cause of the first respiration, but a stimulus exercised on the integument. Prof. Zuntz had quite recently, in conjunction with Dr. Cohnstein, made observations on a new-born lamb that, connected by the umbilical cord with the ewe, came into the world completely apnœic, and, notwithstanding that the most varied stimulations were exercised on the skin, continued apnœic for ten minutes long, though in all other respects these stimulations were normally responded to. Not till the placenta had detached itself did the respiration begin. This observation proved with all certainty that apnœa was dependent on the sufficient supply of oxygen, and that the first respiration was induced by a deficit of oxygen. They therefore repeated the experiments of Prof. Preyer, and came to the conclusion that under them the circulation of the blood always suffered disturbance in consequence of the pressure exerted, whereby the supply of oxygen to the fœtus was impaired, and that the fact which Prof. Preyer adduced in support of the accuracy of his view, namely, that the blood of the umbilical vein always appeared of a bright scarlet red, served exactly to disprove it. The brighter blood of the umbilical vein was, accordingly, an argument of a disturbance in the circulation of the blood, in consequence of which less arterial blood reached the fœtus, and, notwithstanding its greater saturation of oxygen, the blood was, therefore, unable, on account of its deficient quantity, to convey the requisite amount of oxygen to the whole blood. The respiratory centre in the brain thus got supplied with blood poorer in oxygen, and when a stimulation of the skin was superadded the first respiration ensued. In the case of the less excitable brain of the fœtus it was necessary that the outward stimulation should supplement the deficiency of oxygen. In the case of the normally born, however, the detachment from the placenta and the absolute want of fresh oxygen sufficed to stimulate the respiratory centre to activity. In the case of the adult, finally, with excitable brain, a slight reduction of oxygen was itself sufficient to excite respiration.—Referring to the beautiful discovery by Mr. Haycroft, of the fact that the ferment of the saliva in the leech prevented coagulation, Prof. Zuntz recommended the use of this ferment of the leech in measurements of blood-pressure, with a view to avoiding coagulation. This substance had the advantage over all other preventives of coagulation, that in no respect had it any toxic effect. Into the tube conjoining the artery of the animal examined with the manometer of the kymographion a T-tube was intercalated, and by its means a cubic centimetre of the ferment of the leech was squirted per hour into the separate fluid. This was sufficient for the marking of curves of blood-pressure for seven hours consecutively, without the least trace of coagulation.—In view of the divergence of opinions prevailing regarding the alimentary value of the peptones—some maintaining that peptone was used as an alimentary deposit in the body, while others considered that only the albumen absorbed as such was capable of being deposited, the peptones getting, on the contrary, further decomposed—Prof. Zuntz had a number of feeding experiments instituted with peptones. A somewhat long series of experiments was executed on a little dog, first with meat, then with peptone furnished from fibrine, next with albumose substances or propeptones, and, further, with lime. The experiment was arranged in such wise that the dog, along with equal quantities of fat and starch, received daily the like amount of nitrogen. The quantity of secreted nitrogen was daily determined, and thereby the deposit of nitrogen ascertained. The dog first got meat for some days, then peptones for some days, next thereafter meat again, and, following thereon, albuminose substances; this in turn was succeeded by meat days again, then lime days, and, finally, meat days anew. The deposit of nitrogen was now found to amount to—(1) with meat diet, 0·502 grammes nitrogen daily; (2) with peptone, 0·584 grammes; (3) with meat, 0·513 grammes; (4) with propeptone, 0·70 grammes; (5) with meat, 0·46 grammes; (6) with lime, – 0·5 grammes; (7) with meat, 0·48 grammes nitrogen. Meat feeding, accordingly, yielded about the same quantity of nitrogen deposit on each occasion of its being used; in the case of feeding with peptone and propeptone the nitrogen deposit was somewhat greater than in the case of meat-feeding, a result explained by the fact that all the nitrogen of meat did not belong to the albumen, but in part appertained to the nitrogenous bases, which could yield no nitrogen deposit. In the case of lime-feeding, on the other hand, a loss of nitrogen for the body was the result. Prof. Zuntz next had a further series of feeding-experiments performed with the peptones occurring in trade. The dog in question received only fat in addition to the nitrogenous nutriment. In the first days, with meat-feeding, a deposit of nitrogen, to the amount of 0·2 grammes daily, was the result; under feeding with Kämmerich's peptone following thereon, the daily deposit of nitrogen was – 0·4 grammes; the meat days, next succeeding, again yielded 0·2 grammes nitrogen in deposit, while the feeding, thereafter ensuing, with Koch's peptone again showed – 0·4 grammes nitrogen in deposit. The series was closed by meat-feeding, which produced 0·3 grammes deposit of nitrogen. The marketable peptones were therefore, notwithstanding the like supply of nitrogen, incapable of producing a deposit of albumen; on the contrary there rather occurred a loss of corporeal albumen, not so great, however, as when the like quantity of nitrogen was partaken in the form of lime. A series of experiments was finally carried out with the marketable peptones on a dog which for a considerable length of time had been fed only with rice and fat, and had thereby been very much reduced in strength. In this case the first day of feeding with Kämmerich's peptone produced a deposit of nitrogen to the amount of 0·6 grammes; in the following days this deposit was less; and soon the nitrogen showed itself at equilibrium. Under feeding with Koch's peptone, too, the animal, which was very much reduced, was maintained at equilibrium in respect of nitrogen.—Dr. Weyl communicated the results of his further investigation into the constitution of the derivatives obtained from cholestearine, which, at a meeting of the Society before the vacation, he had declared to be terpenes. He endeavoured to determine the molecular weight of those carbo-hydrates which, according to the nature of terpenes, had the composition $(C_5H_8)^n$. The vapour density, determined according to the method of Victor Meyer, showed itself in the lead bath not normal. It corresponded with the composition C_5H_8, thus indicating decidedly that a dissociation had set in during the process of heating. Other terpenes also, such as turpentine oil and camphor, yielded results which were not normal and showed a dissociation into the radical C_5H_8, a circumstance which likewise argued the terpene nature of cholestearine. Dr. Weyl was able, finally, to demonstrate the connection of cholestearine with the terpenes by showing that the latter very beautifully produced the well-known cholestearine reaction. Further experiments with a view to determining the vapour density in a vacuum would perhaps yield the molecular weight of these interesting carbohydrates.

CONTENTS

THURSDAY, DECEMBER 17, 1885

THE NORWEGIAN NORTH ATLANTIC EXPEDITION—CRUSTACEA

The Norwegian North Atlantic Expedition, 1876-78. *Zoology*. XIV. *Crustacea*, IA. and IB. By G. O. Sars. 4to, pp. 280, with 21 Plates and a Map. (Christiania, 1885; London: Sampson Low and Co.)

NO better evidence can be adduced of the growing influence exercised by the cultivation of natural science than in the more ready tendency displayed by the Governments of various countries to promote expeditions for scientific purposes, and a greater willingness to furnish the necessary means for the publication of the results in a satisfactory manner.

Nor can we fail to look back with a feeling of pride to the work accomplished by our own early naturalists, from the days of Banks and Solander (1768-77) to the voyage of the *Beagle* (1844-46), which the "Journal" and "Observations" of Charles Darwin have for ever rendered famous; and down to the recent magnificent results of the *Challenger* Expedition, which its grand publications are rapidly unfolding to us.

The prospectus of the "Norwegian North Atlantic Expedition" was announced in NATURE, June 2, 1881 (p. 108), and the memoir on the *Gephyrœa* by Danielsson and Koren was noticed September 29, 1881 (p. 506).

The present memoir by Prof. G. O. Sars, on the Crustacea, occupies two quarto parts, illustrated by upwards of 600 figures drawn by the author himself from the actual specimens by means of the camera lucida, "thus affording a sufficient guarantee for their accuracy."

One cannot fail to be struck by the results obtained by the author in so comparatively limited an area, over part of which, at least, other naturalists must have already worked. The map embraces the ocean from the North of Scotland to Spitzbergen, and from Norway to Iceland and Greenland; or from 55° to 80° north latitude, and from 40° east to 25° west longitude.

"To avoid repetition in stating localities," writes Prof. Sars, "I have given a list of all the stations at which the dredge or the trawl was used, along with the date, position of the vessel, depth, bottom-temperature, nature of the bottom, and character of the apparatus. With but very few exceptions crustaceans were obtained at all these stations. Moreover, pelagic forms were collected with the surface-net at many other stations not included in the list. At the coast stations enumerated in conclusion, a smaller dredge was made use of, either from a boat, or from the ship when lying at anchor.

"The stations enumerated in the list have all been accurately set off on the map in which the curves of depth for 500, 1000, 1500, and 2000 fathoms are drawn as dotted lines. In the map will also be found a more strongly-marked curve, indicating the boundary-line between the cold and temperate areas, determined from the observed bottom-temperatures. This curve also forms the natural limit of the ocean valley—reaching 2000 fathoms in depth, and "filled at the bottom with ice-cold water—which shelves from the Polar Sea to the tract between Norway and Iceland, and, in the form of a narrow wedge, terminates in the so-called 'Færœ-Shetland Channel,' where it is cut off by a narrow transverse ridge from the great depths of the Atlantic" (p. 2).

Of the list of results of work performed at the eighty-six stations, either by means of the dredge, the trawl, or with "swabs," sixty give a bottom temperature of from 0° C. to 2° C. only; the highest reading being 7° C., in 237 fathoms close to the coast of Norway; whilst the average temperature at the bottom is only 2°·3 C., or 3° above freezing-point.

The deepest dredging recorded in Sars' list is 1861 fathoms, with a bottom-temperature of 1°·2 C.; but at p. 159 he mentions that *Harpinia abyssi* was obtained from a depth of 2215 fathoms.

In treating of the crustacean fauna of this region Prof. Sars has not included forms previously established as belonging to the Norwegian *littoral* fauna. Such forms will be fully treated of elsewhere, in a work on the Crustacea of Norway, to be shortly executed by the author.

Some idea may be formed of the extreme Arctic facies presented by the Crustacea inhabiting the depths of this cold-water area of the North Atlantic by noticing the relative proportions of species appertaining to each order recorded by Sars.

Thus of the BRACHYURA 1 species only is recorded (*Scyramathia Carpenteri*, Norman) from 220 fathoms; a form described and figured in Sir Wyville Thomson's "Depths of the Sea" (p. 175). From the slight development of the eyes and their light-coloured pigment it was probably blind, as is the case commonly with the crustacea from great depths.

Of the ANOMOURA only 1 species (*Eupagurus tricarinatus*, Norman) was taken in about 98 fathoms.

Four species of CARIDEA are described, the largest of these, *Sclerocrangon salebrosus* (Owen), appears to be widely distributed in the northern seas, ranging from 100 to 459 fathoms; but off the coast of Kamschatka, according to Tilesius, it is found abundantly in shallower water, and serves as an article of food to the natives. It ranges from Norway to Spitzbergen (p. 25).

Of the two species of *Bythocaris*, *B. leucopis* G. O. Sars, and *B. Payeri*, Heller, it is interesting to notice that the young of this Caridian do not pass through the usual post-embryonic metamorphosis, or larval stage, but on quitting the remarkably large ova, they are seen to be provided with the full number of appendages observed in the parent. All the species are true deep sea forms (1110 fathoms!), the eyes being unusually small and imperfect.

The next form, *Hymenodora glacialis*, has legs, as in the Schizopods, with a well-developed natatory branch (exopodite) attached to the outer side of the second joint. The eyes are small and imperfectly developed. It would seem to lead a semi-pelagic life, but it was taken at a depth varying from 452 to 1862 fathoms in the cold area.

Of the Schizopoda five species of "opossum shrimps," *Mysidæ*, were taken: *Erythrops gracilis* in from 263 to 498 fathoms, and *Pseudomysis abyssi*, Sars, from 1110 to 1280 fathoms! *Boreomysis nobilis*, 6 mm. long, was taken off the north-west coast of Spitzbergen, 80° N. lat. in 450 fathoms. The most remarkable of these deep-sea *Mysidæ* is the *Boreomysis scyphops*. "The eyes in this species are remarkable alike in character and form, their outer surface being, instead of convex, considerably hollowed, which gives them a well-nigh calyciform appearance. They are attached comparatively close together, in a vertical position, with the convex surface turning in and the concave out! Of any specific ocular pigment, or indeed of any visual elements whatsoever, no trace could be detected in the recently-taken specimens, and subsequent examination fully confirmed the absolute want of such" (p. 57).

One species of *Cumaceæ*, *Diastylis nodosa*, was obtained in 125 fathoms at Ice Sound, Spitzbergen. It has no trace of eyes, the ocular tract being *quite flat*, nor can any pigment or other visual element be seen (p. 63).

Of the ISOPODA 18 species are recorded, including members of the families *Apseudidæ*, *Tanaidæ*, *Anceidæ*, and *Arcturidæ*.

Sphyrapus serratus, Sars, is one of the most remarkable of these, both in the form of its body, of which 13 somites can be seen, and 19 paired appendages (Plate 21). The first pair of legs springing from the posterior part of the cephalic segment, are like the chelipeds in more highly-developed Crustaceans (Decapods), exceedingly powerful prehensile organs. The second pair of legs are as long as the entire body, and are flattened and armed with powerful spines, as if intended to serve as fossorial organs. Five pairs of slender walking appendages follow, succeeded by five pairs of biramous swimming-feet and a pair of long multiarticulate caudal appendages, also branched. The whole appearance of this creature is most remarkable, but it has a strong resemblance to *Apseudes*.

Sphyrapus serratus occurs in the open sea between Norway and Iceland, and also west of Spitzbergen, varying in depth from 1163 to 1333 fathoms, and ranging from the 63rd to the 78th parallel of latitude. Eyes, in a strict sense, are entirely wanting; no trace of visual elements whatever could be detected (p. 68). Of the *Tanaidæ*, three species, belonging to as many genera, were taken; all in deep water and all blind (Plate 7). The colour of these forms, as a rule, is a uniform white.

Not least remarkable among the Isopoda are the *Anceidæ* (Plate 8), most insect-looking of all the Crustacea! "The so-called mandibles (Fig. 6), which, however, as pointed out by Prof. Dohrn, both as regards their position relative to the buccal orifice and their general development, can scarcely be held to be homologous with the mandibles in other Crustaceans, are attached to the foremost margin of the head, and project freely in front of it, admitting of being moved horizontally one towards the other, like a pair of forceps" (p. 88). The larvæ (Praniza) are even more insect-like in appearance than the adult forms (see Plate 8, Figs. 13 and 27). The females of these forms are probably parasitic upon deep-sea fishes, or other large deep-sea animals. The males and larvæ of three species described were dredged from 72° to 78° N. lat., in from 658 to 1215 fathoms; they are all blind forms.

Many beautiful forms of *Arcturidæ*, *e.g.* *Arcturus baffini*, *A. tuberosus*, *A. hystrix*, &c., are figured and described. *A. baffini* was taken as far north as the west coast of Spitzbergen in 416 fathoms, and *Glyptonotus megalurus*, an allied form ranging from 63° to 78° N. latitude, inhabits depths of from 1081 to 1710 fathoms in ice-cold water!

Another strange form is the *Eurycope gigantea*. In this isopod the 2nd pair of antennæ are prodigiously developed, being more than four times the length of the whole body.

The *Amphipoda*, 45 in number, form by far the largest group of Crustacea obtained by the Expedition.

Harpinia abyssi (G. O. Sars, Pl. 13, Fig. 5) was obtained from a depth of from 350 to 2215 fathoms! It is distributed from 63° to 75° N. latitude and from 16° E. long. to 12° W. long. *Epimeria loricata*, a very handsome form, with spinose segments (Pl. 14, Fig. 2) was dredged near Spitzbergen in 260 fathoms. *Oidiceros macrocheir* dredged off Jan Mayen in 1004 fathoms was destitute of eyes (Pl. 15, Fig. 4). *Melita pallida*, another blind form (Pl. 15, Fig. 1), was found inhabiting deserted *Teredo*-burrows in an old piece of wood, dredged up from a depth of 1333 fathoms off the west coast of Spitzbergen.

Several *Caprellæ*, attached to hydroid polyps, were brought up in the dredge from a rocky bottom at 180 fathoms.

Eucheta norvegica, a copepod of the family *Calanidæ* was taken at no fewer than twelve stations at *very considerable* depths, whereas the surface-net at these localities, even when sunk considerably below the upper layer, never contained a single example.

Of the *Cirripedia*, *Scalpellum strömii* was dredged in 870 fathoms attached to the tubes of *Tubularia indivisa*. Five other species were obtained, namely, *S. cornutum*, *S. hamatum*, *S. vulgare*, *S. angustum*, and *S. striolatum*, the last attached to sponges. These are mostly white, and were collected from numerous localities and from varying depths.

A remarkably slender tubular form of *Balanus crenatus* was met with in 21 fathoms north of Beeren Island.

A Rhizocephalon (fam. *Peltogastridæ*) named *Stylon Hymenodore* attached parasitically to the abdomen of *Hymenodora glacialis* (dredged from a depth of 1861 fathoms) completes the list of forms described.

Thirteen additional species are referred to in a supplement as noticed by other writers since the present work was handed in to the scientific editor.

One is struck by the fact that of the 82 species of crustacea obtained by Sars, at these great depths in this ice-cold area, 61 are considered to represent distinct genera! Can it be that the conditions of life are here so hard, and the struggle for existence so severe, that each individual peculiarity becomes intensified, and that not only the cold, but the *darkness* may produce considerable changes in their organisation? Absence of *colour* and absence of *sight* are the prevailing characteristics exhibited by nearly every species; whilst the loss of eyes seems to stimulate the development of all the tactile organs to supply their place, so that we find the same idiosyncrasies of structure manifested in these depths of the ocean as have been observed in the Crustacea of the American and Austrian caves, and from the dark underground waters of various parts of the world.

We should fail in our duty to the author and also to the scientific reader did we omit to point out for high commendation the admirably-prepared plates which accompany Prof. Sars' Memoir, all the details of which are most beautifully and accurately rendered.

And lastly, but by no means the least meritorious feature of the work, is the generous concession made to English and American scientific readers, by the kindness of the Swedish Government, who have caused this Memoir to be printed throughout in a double column, the left hand of every page being printed in Swedish and the right hand in English.

Much praise is also due to the editor and author for the careful manner in which the English portion of the work has been passed through the press, and for the very great care bestowed on its translation from the original Swedish.

CHARLES DARWIN

Charles Darwin. By Grant Allen. "English Worthies," Edited by Andrew Lang. (London: Longmans, Green, and Co., 1885.)

Charles Darwin, und sein Verhältniss zu Deutschland. Von Dr. Ernst Kraus. Darwinistiche Schriften, Nr. 16. (Leipzig: Ernst Günther, 1885.)

IT is a curious illustration of the change which has passed over the English mind, that already the name of Darwin should head the list of a projected series of popular books, not on eminent men of science, but on "English Worthies." This first member of the series is, as might have been expected from its authorship, a pleasing and favourable specimen of a kind of literature for which the public appear to entertain so keen a relish. For it is not only clear and picturesque in style, but is also evidently written *con amore*. Indeed, it was impossible for any man of common sense or common sensibility to have come into any kind of relation with Mr. Darwin, without being stirred by feelings of hero-worship, and Mr. Allen's reverential love for the hero is a natural tribute fittingly rendered to the lofty nature and mighty influence for whose loss the universal grief is still so fresh.

As a biographical sketch the little volume is decidedly a success. It gives in brief compass and good language the history of Mr. Darwin's antecedents, of his life and work, of his relation to contemporary thinkers, and of his presumable influence upon subsequent thought. All of which is done without losing sight of the desirability, in a popular treatise, of upholding the element of romance—a kind of treatment to which the character, the life, and the work of Darwin unite in lending themselves, as it were, by nature.

In his review of the course of thought upon the theory of evolution prior to Darwin, Mr. Allen is judicious; and his speculations upon the probable position of this theory at the present time if Darwin had not lived, are interesting—tending, as they do, to show how indispensable was the work of the great naturalist in focusing the facts and showing the method. Or, to quote a somewhat happy metaphor of his own, "Darwin was not, as most people falsely imagine, the Moses of evolutionism, the prime mover in the biological revolution; he was the Joshua who led the world of thinkers and workers into full fruition of that promised land which earlier investigators had but dimly descried from the Pisgah-top of conjectural speculation."

Almost the only criticisms we have to advance relate to matters of opinion. Thus, for instance, the following passage seems to us absurd:—"Strange to say, the abortive theory [of Pangenesis] appeared some years later than Herbert Spencer's magnificent all-sided conception of 'Physiological Units,' put forth to meet the self-same difficulty. But while Darwin's hypothesis is rudely materialistic, Herbert Spencer's is built up by an acute and subtle analytical perception of all the analogous facts in universal nature. It is a singular instance of a crude and essentially unphilosophic conception endeavouring to replace a finished and delicate philosophical idea." Now we can very well understand any one who has read both the theories including them in the same condemnation, as too highly speculative, devoid of verification, and so forth. But we cannot understand any one thus exalting the one to the disparagement of the other—and least of all so on the ground that Darwin's version is "rudely materialistic." Where can there be room for any other element than the "materialistic" in the case of an hypothesis which has to do with facts purely physiological? The objection to Spencer's version we have always taken to consist precisely in its "acute and subtle perception of all the analogous facts in universal nature," whereby we are gradually translated beyond the world of physiology altogether, until we may exclaim with St. Paul—"Whether I am in the body or out of the body I cannot tell."

And this leads us to a second criticism of a more general nature. Mr. Allen, we think, is too fond of comparing the work of Darwin and Spencer, and when doing so appears to us to attach an altogether undue merit to what he calls the "deductive" as distinguished from the "inductive" method. The work of these two great Englishmen is so unlike that, even though it has been expended upon the same subject-matter, it always seems to us a great mistake to compare them; we might almost as well seek to compare the work of an historian with that of a poet. "What an ex-tra-or-dinary wealth of thought that man has," was once observed to the present writer by Mr. Darwin: "when I first read his 'Principles of Biology' I was speechless with admiration; but on reading it again I felt in almost every chapter—Why, there is here at least ten years' work for verification." Now this is surely a sound judgment, and one, moreover, in no way disparaging to the genius of Mr. Spencer. But if it is a sound judgment, surely also it shows the mistake of comparing his genius with that of the man who wrote the passage more than once quoted by Mr. Allen—"After five years' work I allowed myself to speculate on the subject."

Again, with reference to the relative values in biology of the deductive and inductive methods, Mr. Allen appears to us behind the age. To quote only one passage, he says:—"The English intelligence in particular shows itself as a rule congenitally incapable of appreciating the superior logical certitude of the deductive method. Englishmen will not even believe that the square on the hypotenuse is equal to the squares on the containing sides until they have measured and weighed, as well as they are able by rude experimental devices, a few selected pieces of rudely shaped rectangular paper." Now, it is easy to sustain the doctrine here implicated with examples drawn from Euclid; but biology is not mathematics, and if any one truth more than another is necessarily and forcibly brought home to the intelligence of a biologist—be he "English" or otherwise—it is the truth that in his science it is safer to cut out his materials in the way of experiment, than it is to build up his propositions in the way of deduction. Therefore, it is not without good reason that a proved "soundness" in this way of inductive research should be regarded as the best title to a place among men of science as distinguished from men of letters. "To be sound," says our author, "is everywhere of incalculable value;" and to be sound in the present sense, "to have approved one's self to the slow and cautious intelligence of the Philistine classes, is a mighty spear and shield for a strong man; but in England, and above all in scientific England, it is absolutely indispensable to the thinker who would accomplish any great revolution. Soundness is to the world of science what respectability is to the world of business—the *sine quâ non* for successfully gaining even a hearing from established personages." And long may it continue so. Surely this acknowledgment of the supremacy of the inductive over the deductive methods has been gained by a sufficiently long struggle in the past, and surely the tardiness of this acknowledgment has been fraught with evils sufficiently conspicuous to render somewhat grotesque the term "Philistine classes" as thus applied to the devotees of observation and experiment.

There is only one other passage upon which we have anything resembling a criticism to pass, and we notice it the more readily because, while it relates to a somewhat important matter of fact, the fact is one the unwitting and quite excusable misstatement of which by the present biographer furnishes a good opportunity for rendering its true complexion. In his chapter on "The Period of Incubation of the Origin of Species" Mr. Allen says:—

"His way was to make all sure behind him, to summon up all his facts in irresistible array, and never to set out upon a public progress until he was secure against all possible attacks of the ever-watchful and alert enemy in the rear. Few men would have had strength of mind enough to resist the temptation offered by the publication of the 'Vestiges of Creation,' and the extraordinary success attained by so flabby a presentation of the evolutionary case: Darwin resisted it, and he did wisely. We may, however, take it for granted, I doubt not, that it was the appearance and success of Chambers' invertebrate book which induced Darwin, in 1844 (the year of its publication), to enlarge his short notes 'into a sketch of the conclusions which then seemed to him probable.' This sketch he showed to Dr. (now Sir Joseph) Hooker, no doubt as a precaution to insure his own claim of priority against any future possible competitor. And having thus eased his mind for the moment, he continued to observe, to read, to devour *Transactions*, to collate instances, with indefatigable persistence for fifteen years longer."

Now, we have quoted the whole of this passage because it serves to convey, in clearly expressed language, what is a very general misapprehension with regard to the length of "the incubation period." But Mr. Darwin has himself told the present writer that the reason why he was so long in publishing his theory was simply because he wished to be fully persuaded in his own mind as to its truth before he incurred the moral responsibility of giving it to the world. Most of all those twenty years were occupied in collecting evidence, and in that process of self-criticism which he used to call "meditation," with the single-minded view of self-persuasion. Here was surely a nobler motive, and one more worthy of an "inductive mind," than that of accumulating evidence merely in order to make out a good "case." We doubt whether the popularity of the "Vestiges" exercised the smallest influence upon Mr. Darwin's motives. He had no desire to make a stir merely in order to secure a literary success; and therefore he felt that the more attention his work was likely to attract the more pernicious was it likely to prove, unless it was throughout founded upon truth. Neither was he actuated by any petty regard for priority. The reason why he showed his notes to Dr. Hooker was because he entertained a higher regard both for the learning and the judgment of this friend than he did for those of any other man.

By a curious coincidence Dr. Kraus's biography of Darwin appears in Germany about the same day as Mr. Allen's in England. As we have thus received the two by consecutive posts, it is impossible to avoid comparing them. And the comparison is interesting, as showing the differences between the public tastes to which the biographies are respectively addressed. While the English volume is a pleasing sketch of a great life, the German counterpart is an honest piece of history. Dr. Kraus has spared no pains in making his work thorough. He has carried his investigations through the smallest detail of Mr. Darwin's life and labours; he has brought together a number of letters written by Lyell, Hooker, Haeckel, Müller, &c., and also by Darwin himself; he has given a methodical account of the opinions entertained upon Darwinism by all the naturalists of any note in Europe and America who have either written or spoken upon the subject; and he has done all this without losing sight of the strong personal interest which attaches to the character of the immortal Englishman.

Many of Mr. Darwin's own letters just alluded to are translations of those written to Prof. Henslow during the voyage of H.M.S. *Beagle*, and printed for private circulation among the Fellows of the Philosophical Society of Cambridge. But all the others are translations of letters now printed for the first time—the originals having been lent for this purpose to Dr. Kraus by Haeckel, Preyer, Fritz Müller, and others. These letters are all more or less effective in displaying the distinctive qualities of their author's mind; but if we were requested to indicate one more than another which is of interest in this respect, we should mention the one to Haeckel in which the following passage occurs. The original English is not given:—

"Ich hoffe, dass Sie mich nicht für unverschämt halten werden, wenn ich eine kritische Bemerkung mache: Einige Ihrer Bemerkungen über verschiedene Autoren erscheinen mir zu streng, obwohl ich kein gutes Urteil über diesen Gegenstand habe, da ich ein so kümmerlicher Schulknabe im Deutschlesen bin. Ich habe indessen von verschiedenen ausgezeichneten Autoritäten und Bewunderern Ihres Werkes Klagen über die Härte Ihrer Kritiken vernommen. Dies scheint mir recht unglücklich, denn ich habe seit lange beobachtet, dass grosse Strenge die Leser verführt, die Partei der angegriffenen Person zu ergreifen. Ich kann mich bestimmter Fälle erinnern, in denen Herbigkeit direkt das Gegenteil der beabsichtigten Wirkung hervorbrachte. Mit Sicherheit empfinde ich, dass unser guter Freund Huxley, obgleich er viel Einfluss besitzt, noch weit grösseren haben würde, wenn er gemässigter gewesen und weniger häufig zu Angriffen übergegangen wäre. Da Sie sicherlich eine grosse Rolle in der Wissenschaft spielen werden, so erlauben Sie mir, als älterem Mann, Sie ernstlich zu bitten, über das nachzudenken, was ich zu sagen gewagt habe. Ich weiss, dass es leicht ist zu predigen und scheue mich nicht, zu sagen, dass, wenn ich das Vermögen besässe, mit treffender Schärfe zu schreiben, ich meinen Triumph darin setzen würde, den armen Teufeln das Innere nach aussen zu kehren und ihre ganze Albernheit blosszustellen. Nichtsdestoweniger bin ich überzeugt, dass dies Vermögen nicht gut thut, sondern einzig Schmerz verursacht. Ich möchte hinzufügen, dass es mir, da wir täglich Männer von denselben Voraussetzungen zu entgegengesetzten Schlüssen kommen sehen, als eine zweifelhafte Vorsicht erscheint, zu positiv über irgend einen komplizierten Gegenstand zu sprechen, wie sehr sich auch ein Mensch von der Wahrheit seiner eigenen Schlüsse überzeugt fühlen mag. Und nun, können Sie mir meine Freimütigkeit vergeben? Obgleich wir einander nur ein einziges mal begegnet sind, schreibe ich Ihnen, wie einem alten Freunde, denn das sind meine Empfindungen Ihnen gegenüber."

The chief value of the German biography consists in its setting forth the early recognition, the rapid spread, and the present acceptance of Darwinism in Germany. Dr. Kraus has always an easy case where he is displaying the old truth about a prophet among his own kindred. It was not until after we had well stoned our prophet that the nation began to recognise the reality of his mission; and, as Dr. Kraus remarks, it was not until after we had lost him that England was awakened to the true magnitude of her greatest son. So it was that, Samson-like, he slaughtered his enemies even in his death, and this on a scale which would have astonished no one more than himself, could he have lived to see it.

Dr. Kraus's narrative everywhere glows with an enthusiastic admiration of Mr. Darwin's character, and on this account he deems no trait of thought, expression, or even of movement, too trivial for the purpose of rendering a mind's-eye portrait to his reader. On the whole, this word-painting is accurate, and the workmanship in good taste. As he himself remarks, however, exception may perhaps be taken in the latter respect to his having entered upon the religious opinions of the naturalist. But as he has only collected material upon this subject which had already been published, and as he re-publishes this material in an excellent spirit of toleration towards all varieties of religious belief, we do not ourselves think that he can be justly said to have overstepped the limits of good feeling.

From this brief notice it may be gathered that Dr. Kraus's book is both a thorough and an interesting piece of biographical work; and we must not forget to add that its interest is enhanced by two portraits of Darwin (one, the last that was taken, and the other a likeness of him as a young man), a picture of his house in Kent, and a facsimile of one of his letters.

GEORGE J. ROMANES

OUR BOOK SHELF

British Zoophytes; an Introduction to the Hydroida, Actinozoa, and Polyzoa found in Great Britain, Ireland, and the Channel Islands. By A. S. Pennington, F.L.S. (London: L. Reeve and Co., 1885.)

THE object of this book is to furnish a handy, and at the same time reliable, manual of British zoophytes, using this term in somewhat the same sense as Dr. Landsborough did; and the author aims at making it do for the present generation of students what the reverend doctor's "Popular History of British Zoophytes" did for those of a former one.

In so far as the object of the author has been to furnish a catalogue of the Polyzoa and most of the Cœlenterata of the British Isles, this has been fairly fulfilled, and, as far as we have been able to judge, the catalogue is in most instances a reliable one; but the student will not find it a ready help to the determination of the species; for though in most cases the diagnoses of the genera are given, yet it is but rarely that there is enough of a hint given as to the specific characteristics of a form to enable its name to be even guessed at; so that the working biologist interested in naming the species he collects must still have by him the works of Gosse, Hincks, and Busk. The usefulness of this volume would undoubtedly have been vastly increased if the labour had been gone through of giving analytical tables of both the genera and species, and it seems to us very undesirable that new species should be introduced into a work like this without detailed diagnosis. The size of the volume need not have been greatly increased if a uniform diagnosis of the species had been attempted, for then no doubt would have been curtailed the quotations, often of no scientific value, from the writings of Dalyell and others.

We have also to regret that the list of the habitats seems to us not to have been judiciously selected. Thus, in the case of some of the rarer forms, it is not unusual to find the exact English localities given, but these followed by such indefinite indications as "Irish" or "Scotch" coasts.

In the introductory chapter we find a somewhat ambitious attempt to write the history of the progress made from 1599 to the present time in our knowledge of "zoophytes." We have no wish to be critical on the facts mentioned, but to find the writings of Trembley, Peysonnel, Réaumur, Ellis, and Fabricius quoted, and the name of Esper, emphatically the eighteenth-century authority on this "group," not even alluded to, strikes us as curious.

As long as the author had the writings of Hincks, Busk, or Gosse to depend on, there he has been at his ease; but in the few cases where he has had to go unaided, as among the Alcyonaria, it is evident that he would have been the better for some help. In such instances, as indeed all through his work, he would have found more assistance from "Carus Prodomus Faunæ Mediterraneæ" than from isolated papers in our scientific journals.

The bibliography in Appendix A is quite unworthy of the name. From it alone no student would, without assistance, find out even what the authors wrote about. Fancy bibliographical references in these modern days, and in a work written for the present generation, of this style:—

1742. Réaumur, "Histoire des Insectes."

1821. Deslongchamps, "Encyclopédie Méthodique."

1838. Milne-Edwards, "Recherches sur les Polyps."

1864. Rev. A. M. Norman, "Contributions to 'Ann. of Nat. Hist.,'" &c.

1884. Andrés, "Die Actinien."

In Appendix B—the glossary—many words are given without any explanation of their meaning; thus, while we learn that *aperture* is "an opening or orifice," and that *orifice* is an "opening," that *apex* is "the top of anything," &c., we have such words as the following left unexplained: *avicularia*, *bathymetrical*, *calyx*, *epistome*, *funiculus*, and so on.

It is just on such matters as we criticise that we have a right to expect in a compilation that care should be taken. The general usefulness of such a volume depends on the way in which each detail is worked out. Motives that the reader of the preface will understand make us refrain from any criticism on the plates, save that the figures are for the most part of necessity from the originals in Van Voorst's well-known series.

Handbook of Jamaica, 1885 86. (London: Stanford.)

THIS is one of the most comprehensive books of the kind that has come under our notice. Everything connected with this interesting colony finds a place in it. The history of the island, for instance, and the geographical description of it might be read with advantage by the most general reader. Of special interest to scientific readers is the full account of the public gardens and plantations, now under the efficient control of Mr. Morris, whose reports we have noticed from time to time as they were published. In the "Handbook," however, a history of the department since 1774 is given; and it is curious to notice the influence it has had on the prosperity of the island. Except pimento, "that child of nature," and a few others of comparatively little value, most of the staple products of Jamaica are derived from exotics or plants introduced from other parts of the globe. Thus the sugar-cane, in its several varieties, coffee, the mango, logwood, cinnamon, the bamboo, mulberry, mimosa, camphor, clove and pepper plants, and many other products of great commercial importance to the island, were unknown a century and a half ago. The manner in which they were brought in is given from historical sources. Thus, that most important industry, cinchona-planting, was only introduced in 1861, on the recommendation of the late Sir William Hooker; the first seeds were planted in the Botanic Gardens, and the first plants reared and distributed from there. In 1884 73,533 lbs. of cinchona bark, valued at 16,327*l.*, were exported from Jamaica. Many other examples of the great economical benefits of these Botanic Gardens on Jamaica might be selected from the interesting historical account of them given in this handbook. The sketch of the Jamaica Institute is also of much interest.

Syllabus of a Course of Lectures on Physiology, delivered at Guy's Hospital. By Dr. P. H. Pye-Smith. (London: J. and A. Churchill, 1885.)

THIS volume consists of the outlines of lectures given from time to time by the author at Guy's. The author, in publishing it, aims at giving the student a help to systematic reading and self-examination, as also to recall to all who take an interest in physiology, the chief facts of this important subject.

Consisting, as it does, of the heads and indications of subjects, this work is one that naturally cannot, in the ordinary sense of the term, be read through, nor will it serve in any way to cram a student for an examination: but we have kept it by us, and from time to time returned to its pages with ever-increasing interest. Though long past the period of life usually described as the "student stage," the ideas presented to us in this book, whether concerning facts, theories, or the deeply-interesting history of the subject, have compelled us to become students again, and we feel it a duty to urge our younger brethren, who are engaged in their first studies of physiology, to consult this little volume, as it is meant to be consulted; and if there be in them the smallest measure of an aspiration for a knowledge of a science as important as it is fascinating; if they be earnest, honest students, they will thank us for calling their attention to a volume which, in a small space, compasses so vast a subject.

Nature and Her Servants; or, Sketches of the Animal Kingdom. By Theodore Wood. (London: Society for Promoting Christian Knowledge, 1886.)

THIS is a well-intentioned little work, illustrated by a set of, for the most part, unobjectionable woodcuts. It is intended for the young, and so scientific terms have been almost wholly discarded. The author states very correctly, that in order to impress a fact upon the mind of a child, that fact must be presented in an interesting and attractive manner, and it is presumably bearing this in mind that he has selected the title to his volume, for children soon learn to know all that is attractive and interesting in the conception of a servant, and the child that reads the introductory chapter to these sketches of the animal kingdom will have this subject brought before him in full detail. But as the thinking child reads on, will his tender mind not be frightened at the notion so forcibly dwelt upon by Mr. Wood, that this serving Nature means that the strong servants should kill and swallow the weak; that while by one law of "Mistress Nature" the servants are to increase and multiply, by another law of the same Dame the feeble and the little ones are destroyed by the strong and the big, and that it is thus that these servants, now become foes, "fulfil their trust." The young inquirer who reads this on the first page may find it hard to agree with the statement on the last page, that "Nature is a good mistress, and provides her servants with all that they may require."

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Whole Duty of a Chemist

I HAVE read with much interest your article on "The Whole Duty of a Chemist." To me it appears perfectly clear that he who does good work in professional science and is paid highly for it, is accorded less honour than he who does equally good work in original scientific research and receives no personal payment, because the former receives a pecuniary reward for his labour whilst the latter does not; the least honour is given where there is the least self-sacrifice. The man who does original research with the ultimate object of securing remunerative scientific employment, works with a less unselfish motive and object than he who does such research from a pure love of truth and a desire to benefit mankind. But whilst the pursuit of new knowledge has always been considered a nobler occupation than the pursuit of money, most scientific investigators do some remunerative work, and workers in both departments are necessary for the general welfare. G. GORE

Institute of Scientific Research, Birmingham

The Recent Star-Shower

LA pluie extraordinaire des étoiles filantes du 27 Novembre, 1872, s'est renouvelée cette année le même jour et à peu près avec la même intensité. D'après les télégrammes et les rélations que nous avons reçus en grand nombre jusqu'à présent, il résulte que le phénomène en question a été remarqué dans toute l'Italie depuis les Alpes jusqu'à l'extrémité de la Sicile, et qu'il se produisit partout sous les mêmes formes. Il commença à la tombée du jour. A Tarente, à 5 heures du soir, les étoiles jaillissaient et filaient en lignes si compactes qu'elles perçaient de temps en temps l'obscurité déjà avancée de la nuit. A Palerme quelques-uns de nos anciens élèves ingénieurs comptèrent 4600 météores de 5h. 15m. à 6h. 30m. A cette heure la pluie météorique se manifestait en plusieurs autres endroits avec une abondance tout à fait surprenante.

Dans notre Observatoire on commença à explorer le ciel à 6h. du soir (temps moyen de Rome). Nous avons suivi la même méthode que je suivis in 1872; les observations actuelles peuvent en conséquence étre comparables avec celles d'alors. Comme j'eus déjà plusieurs fois l'occasion d'exposer cette méthode je crois à propos de l'omettre ici. Je me bornerai à rapporter les résultats obtenus de 15 en 15 minutes; et âfin de mieux éclaircir ma rélation, je vais donner ci-dessous un tableau dont la seconde colonne indique le nombre des observateurs chaque quart d'heure ; et la troisième l'état de l'atmosphère en dixièmes de ciel libre. La quatrième colonne contient le nombre des météores réellement comptés, et la dernière le nombre supputé des étoiles, c.á.d., le nombre qu'on aurait dû avoir par conjecture si les observateurs eussent été toujours au nombre de quartre et que le ciel eût été toujours serein.

Durée de l'observation	Nombre des observateurs	Dixièmes de ciel découvé	Nombre des météores	
			Observés	Calculés
6.0 — 6.15	2	10	2800	5600
6.15— 6.30	2	10	3400	6200
6.30— 6.45	$2\frac{1}{5}$	10	3400	6200
6.45— 7.0	3	10	4500	6000
7.0 — 7.15	4	10	6200	6200
7.15— 7.30	4	7	3500	5000
7.30— 7.45	$3\frac{1}{2}$	7	3100	4900
7.45— 8.0	4	7	3200	4600
8.0 — 8.15	4	7	3100	4400
8.15— 8.30	4	7	1700	2400
8.30— 8.45	4	6	1500	2500
8.45— 9.0	4	5	1000	2000
9.0 — 9.15	4	5	800	1600
9.15— 9.30	4	4	600	1500
9.30— 9.45	4	4	500	1200
9.45—10.0	3	3	234	1000
10.0 —10.8	4	3	312	1000
Heures 4.8	—	—	39,546	623,000

Le ciel fut obscurci à 10h. 8m. par un épais brouillard, qui le déroba à nos yeux tout le reste de la nuit. Ailleurs aussi de noires vapeurs voilèrent le ciel à la même heure et même avant. Seulement dans quelques localités de montagne et du midi où le ciel se conserva serein jusqu'à l'heure la plus reculée de la nuit on affirma d'un commun accord qu'à 11 heures le phénomène était presque fini. Les observations que nous avons faites dans les deux soirées suivantes du 28 et du 29 nous conduisirent à un résultat identique.

En 1872 nous en vûmes 33,000 dans l'espace de six heures ; cette fois-ci, quoique les observateurs ne fussent pas toujours au nombre de quatre comme à cette époque, nous en avons compté 39,000.

En 1872 l'abondance des étoiles atteignit son maximum entre 7h. 45m. et 8h. 45m. ; cette année au contraire le maximum avait eu déjà son commencement, quand le phénomène prit à paraître, ainsi que le prouvent les nombres calculés à Moncalieri dans les deux premières heures, lesquels sont presque constants. Beaucoup ont assuré que dès la nuit du 26 au 27 on vit une grande foule des météores sillonner les airs ; ici le ciel était chargé. Les observations des régions orientales répandront plus de lumière sur ce sujet.

En 1872 nous étions toujours au nombre de quatre observateurs et nous comptâmes 18,600 étoiles filantes pendant les deux heures proches du maximum, tandis que cette fois-ci, dans le même temps et presque toujours au nombre de deux ou de trois, nous sommes parvenus à la chiffre imposante de 29,800. Nous nous hâtons cependant de dire que toutes ces chiffres ne donnent qu'une estimation approximative de l'apparition, puisque pendant ces deux heures on ne comptait guère chaque météore, mais les groupes des étoiles seulement (et pas même tous), qui se succédaient presque sans interruption.

Par conséquent les résultats obtenus dans ce temps ne représentent que la cinquième ou la sixième partie et peut-être sont-ils inférieurs au réel.

Je crois donc ne pas m'abuser en assurant que le nombre des étoiles apparues dans le temps de nos observations n'a pas été au-dessous de 150 à 160 milles. Le spectacle qui s'offrit à nos yeux pendant les deux premières heures du maximum était surprenant, et tel qu'on trouverait de la peine à la décrire. De toutes les parties du ciel il pleuvait des masses d'étoiles semblables à des nuages cosmiques qui ce fondaient. Elles étaient suivies de traces lumineuses, et beaucoup de ces étoiles surpassaient celles de première grandeur ; quelques-unes même étaient de véritables bolides. La marche était, en général, lente, et la couleur prédominante était le rouge tant à Moncalieri qu'ailleurs occasionnée par les nombreuses vapeurs éparses dans l'atmosphère. Les méteores qui se trouvaient le plus près des régions irradiantes étaient très courts : aussi plusieurs n'étaient-ils que des points flamboyants par lois de prospective.

La plus grande partie jaillissait de la région même dont elles irradiaient en 1872, et laquelle se trouve entre Persée, Cassiopée, et Andromède. On ne distinguait aucun centre sécondaire comme dans les soirées ordinaires de la plus grande affluence.

Je mis tous mes soins à déterminer exclusivement la position du radiant, ce qui ne présentait aucune difficulté. Voilà de quelle manière je m'y pris. Je fixai attentivement sa position approximative, et ensuite je traçai sur le papier le chemin de quelques-uns de ces météores qui se détachaient autour de ce point. J'achevai de cette façon presque 190 trajectoires, dont chacune à son tour en représente une infinité d'autres, qui suivaient le même chemin. En partageant ces trajectoires en trois groupes, j'ai obtenu les trois positions suivantes :—

	h. m.		Radiant
A	7 35	... ...	$\alpha = 22°, \delta = +44°$
,,	8 20	... ...	$\alpha = 26, \delta = +43$
,,	9 8	... ...	$\alpha = 28, \delta = +42$

Ces points sont compris entre ϕ et γ d'Andromède et le troisième point est tout près de cette dernière étoile.

Mon savant collègue, M. Schiaparelli, eut pour résultat :—

	h. m.		Radiant
A	6 35	... ...	$\alpha = 15°, \delta = +45°$
,,	7 12	... ...	$\alpha = 18{\cdot}5, \delta = +44$
,,	8 7	... ...	$\alpha = 23, \delta = +42$

En conclusion, la grande quantité de météores observés de ces jours est la même que l'on vit en 1859 et en 1872 ; elle se présente avec un interval le de 13 ans qui correspond à la double période de la comète de Biela-Gambart, avec laquelle cet essaim météorique a des rélations immédiates.

P. J. DENZA

De l'Observatoire de Moncalieri, 30 Novembre

ON the night of November 27, when off the Straits of Gibraltar, time 6 p.m. (6.45 G.M. time), weather fine and clear, sky cloudless, I witnessed what must be of rare occurrence in high northern latitudes—a fine meteoric display, unsurpassed by anything of the kind I had the good fortune of seeing before.

From a point in the heavens situated about the Elliptical Nebula (31 M) in Andromeda radiated in all directions towards the horizon, an immense number of meteors, numbering, as far as I could count, about 30 per second from 6th mag. to beyond the apparent magnitude of Venus, as best seen, the greater number of which were apparently of the 2nd to 4th mag. and plainly visible through a space of 40°, travelling, as far as I could judge, about 10° per second.

This display continued without intermission to about 10.30 p.m., when the light of the rising moon put an end to its brilliancy, though the larger meteors still continued to be seen throughout the night.

I noticed one large meteor in particular, far surpassing Venus in magnitude and splendour, burst forth from a spot about 10° south-west of Markab, and, after traversing a space of 60° in a south-westerly direction, suddenly disappear, leaving behind it a long train of bluish-white light, which after the disappearance of the meteor began to assume different forms. The lower part of the line recurved on its path, travelling to the south-east, east, and north, until it finally joined the upper line, forming an elongated ellipse which appeared plainly to the naked eye for the space of 15 minutes. It had the appearance, when viewed through a pair of binoculars, of a light white cloud that the moon is just illuminating, and in its passage across A and V Aquarius (as the body of it still held a northerly direction) it made them to appear as if light steam was passing across them. It finally disappeared like round nebula to assisted sight after being seen for over 25 minutes.

The whole display might be likened to a huge umbrella, 31 M, the radiating point being taken for the point or apex and the shooting-stars the ribs.

The most brilliant and largest meteors held invariably a south-easterly to south-westerly direction, and the radiating-point was situated during the display from 30° east to 30° west of the zenith. JOHN M'KEAGUE

s.s. *Acadia*, December 3

A MAGNIFICENT meteoric shower was visible here on November 27, from soon after sunset till the sky was clouded over at midnight. The maximum appears to have been between 8 and 9 o'clock.

At 6h. 30m. two observers watching opposite parts of the sky counted 850 meteors in 5 minutes. At 7h. 50m. (5h. 30m. Greenwich mean time) seven observers divided the heavens among them and together counted 525 in one minute. We all agreed that we had not been able to count all that we saw, so that this number is probably too small. At any rate I do not think the number of meteors visible between 7 and 9 p.m. was at any time less than 500 per minute. At 10h. I alone counted 210 in two minutes, facing the north, which was then partially clouded.

The majority were small, though quite a number were estimated as brighter than Venus. Nearly all had trails, usually bluish-white, but frequently reddish in the case of the larger ones. At no time did I see a trail remain visible more than three seconds after the disappearance of the meteor; some friends saw one which remained visible about five minutes, changing its shape a number of times and gradually vanishing.

I determined the radiant-point carefully by tracing back the paths of a great many. I place it 2° or 3° north-west of γ Andromedæ, R.A. 25° or 26°, $\delta + 43°$ or $+ 44°$. And three times during the evening I saw meteors appear at this point, grow brighter, and die away at the same place, as though coming directly towards the observer. ROBERT H. WEST

Syrian Protestant College, Beyrout, Syria, November 30

I CAN quite confirm what Dr. Main says about the display of meteors being finer in this neighbourhood than seems generally to have been the case, as far as the accounts which I have seen enable me to judge. My attention was not called to the falling-stars until the display was past its best; but at about 7.30 p.m. I held my opera-glass steadily on one spot, and, watch in hand, counted the numbers which crossed the field of the glass, and, repeating this two or three times, I found that more than one per second crossed the field. The exact figures were eleven each ten seconds.

I hastily set up a Coulomb's torsion electrometer, and found the air highly charged with electricity, which may possibly not be without interest in considering the auroral displays mentioned in NATURE. ARTHUR WM. WATERS

Davos Dörfli, Switzerland

THE Bielid meteors were observed here last evening (November 27) in considerable numbers. I had been closely occupied during the day, and had quite forgotten that they were due, so that I did not look out for them immediately after dark, and probably missed the maximum of the shower. On going out of the house at 7.15 (Eastern Standard Time, 5h. later than Greenwich) my attention was at once attracted by seeing two meteors in the sky together, quickly followed by others. In walking about 100 yards I counted 12, and in 10 minutes 36. Up to 7.45 about 100 were recorded in all; in the next 15 minutes only 3 or 4 appeared, and at 8 o'clock I discontinued the observations. Five or six were of the 1st magnitude; about half of the whole number were of the 2nd or 3rd, and the rest of them were mostly very small. The colour, both of the meteors and of their trains, was always *reddish*—never greenish like that of the Leonids. The tracks were generally short, in very few cases exceeding 20°, and the motion was rather slow. The position of the radiant, determined largely by three nearly stationary meteors, but agreeing also with results obtained by plotting other meteor paths, was about 2° north-west from γ Andromedæ:—α, 1h. 50m.; δ, 43°·5. The radiant was not a point but rather a region about 4° long north and south, and 2° wide. C. A. YOUNG

Princeton, N.J., U.S.A., November 28

THE meteors were seen here till 7h. 10m., when the sky became overcast. They were first noticed before it was dark, as early as 4h. 35m. and they were then abundant, though smaller ones must have been hidden by the twilight. Although cloudless, the night was not favourable, and below an altitude of 45° there was much haze, so as to sensibly dim meteors that descended below this altitude.

Scarcely any of the meteors had an apparent nucleus. Nearly all appeared as sparks, and at first scarcely increased in size, at last suddenly blazing out into a considerable number of sparks, and then almost immediately disappearing, and there was an absence of the usual lingering streaks. The meteors were remarkably abundant, especially before 6 p.m. At 5h. 25m., facing south-east, I counted 21 in ten seconds, whilst a gentleman facing north-west counted 17. The number seen between 5 p.m. and 6 p.m. must have been at least 100 per minute. Though the meteors were almost constant, they were spasmodic as regards numbers, for every few minutes suddenly the air seemed full of them. Very few were erratic, and the stream going in one direction was a conspicuous feature. Meteors passing over the same path were alike as regards the length of their paths, with this qualification: the smaller ones were invisible sooner than those of larger size.

The average size of the larger ones was not great, yet early in the evening they were larger than those seen in 1872. The largest was seen exactly at 5h. 30m.; this passed close to α Andromedæ, and it was about equal to the apparent size of Venus.

Near the point of convergence, not far from γ Andromedæ, the paths were very short, and on the point itself there were no less than five that blazed out and died away without moving, three were mere points, and two were equal to Sirius in apparent size; they also disappeared at their maximum brightness, but did not separate into sparks.

There was evidently a second point of convergence near η Cassiopeiæ, and these meteors were not as brilliant as those converging to γ Andromedæ; no stationary ones were, however, noticed here.

The general colour was that of ordinary gas, a few only being intensely blue. Those nearer the horizon had a red look, but this was owing to the haze, for their colour only changed when passing into this haze.

In 1872 one meteor—a mere spark—I saw between me and a hill (80 feet elevation), and again to-night two others passed between me and a hill. These must have fallen to the ground. They were moving almost horizontally.

The display this evening, both as regards numbers and general appearance, was very similar to that of 1872

Shirenewton Hall, Chepstow, November 27 E. J. LOWE

P.S.—Owing to work in connection with the General Election this report was unfortunately not posted on the 28th. The 28th was unusually clear, with an absence of clouds; but from 8 p.m. till 9 p.m. I only noticed two meteors, and they came from the direction of Cassiopeia.

THE expected meteoric shower was seen here between 8 and 8.30 on the evening of November 27. The weather was misty and the sky partly overcast.

The stars fell in great numbers from an invisible (owing to cloud obscuration) radiant-point in or near Andromeda, and with a slow motion, their movement being more like that of large flakes of snow falling gently through the air than that of shooting-stars. Numbers fell, apparently perpendicularly; the greater part, however, took a southerly and south-westerly direction, very few taking an eastern and north-east course. The display was intermittent, occasionally nearly ceasing, and then showering in great numbers, which it was found impossible to count. About 8.30 p.m. the sky was completely overcast, and drizzly rain was falling.

The meteors were of uniform size and of the same colour—a bright whitish-yellow. A few of larger size were seen, and these were somewhat darker and their flight more prolonged.

WM. H. LYNE

British Cemetery, Scutari, Constantinople

WITH reference to Mr. Haslam's remarks (NATURE, December 10, p. 128) as to the coincidence of auroræ with star-showers, I believe that their combined apparitions have no meaning further than that resulting from pure accident. I have seen many rich star-showers without the faintest visible trace of auroral manifestation, and many bright displays of auroræ have been watched here without indication of an associated star-shower. Still, the circumstance that certain meteoric displays have occurred contemporaneously with other phenomena, is interesting (though not, perhaps, significant, as intimating any physical connection), and such records should always be preserved, as possibly having a value which further observations may elucidate.

During the great meteoric shower of November 13, 1866, several observers detected a faint diffused light of an auroral character in the northern sky.

In 1880 there were bright displays of auroræ on August 11, 12, and 13. Whilst watching the Perseid meteor-shower on those nights, I noticed the successive appearances of streamers and light condensations in the northern quadrant. On the 13th the sky was much lighter than usual, though no streamers or bright glows were visible. The moon set before 10h., yet at midnight the air was not dark; objects around were discernible with remarkable facility beneath the luminous gauze of the aurora apparently diffused over the sky.

During the present month I have been engaged in a series of observations of the Geminid meteor-shower. On December 7, 8, 9, and 10, I especially noticed singular light-radiations, like broad films of faint white cloud, in the northern region. These were very striking on December 9, and persistent during several hours. The most conspicuous of these radiations stretched out of the horizon in the north-north-east, and ran obliquely a considerable distance east, where it enveloped the stars of Virgo and Leo. The effect was somewhat similar to that of the zodiacal light, but in the present case the phenomenon had an evident tendency to remain in the vicinity of the horizon. On its upper side I distinguished very faint indications of streamers, with alternating spaces rendered very dark by contrast. The appearances were, however, so constant, that they can hardly be associated with the characteristic mobile forms of ordinary auroræ. The sky generally was very light, and I have specially noticed this fact on several other occasions this month, when an observer might readily have assumed that the moon, in one of her quarters, was present in the firmament.

A suffused glowing of the whole sky such as that now recorded has not infrequently been visible here in past years during the progress of meteoric observations. Though no definite auroræ (in its normal features) can be descried, there is obviously some modification often present imparting to the firmament those peculiarities of aspect and tint which are far too striking to escape notice. I believe that scarcely a very clear night passes but there may be traced, with a critical eye, some feeble traces of auroræ, or their closely-allied phenomena. Could these ever-varying sky-tints be studied in a fine climate, I feel assured we might look for some interesting results.

Bristol, December 12 W. F. DENNING

The Supposed Fall of an Aërolite in Naples

THE late beautiful meteoric display, which was well seen here, has given rise to a somewhat ludicrous incident. The local papers on Sunday evening and Monday contained an account of an aërolite that had fallen in the Strada Fiorentino, one of the principal thoroughfares of the town; that this stone weighed between 6 and 7 kilogrammes, and had nearly struck some people who were passing. This announcement was followed by a description of the stone from the pen of one of the professors in the University, together with an account of meteorites in general.

Such a display of erudition, coinciding with the bombardment our earth has had from Biela's comet, prevented my sleeping all night, and, as early as etiquette would allow, I paid a visit to the house of the two professors, the *happy* (?) possessors of this would-be aërolite. The first examination convinced me that we had to deal with a shoemaker's lapstone of Vesuvian lava, the patina being nothing more than the polish of grease, dirt, with wear and tear. A small fragment was given me, which, after being sectionised, showed a typical leucitophyre of Vesuvius—probably the lava of 1631 from "La Scala" quarries.

I should not have written to you had it not been that such confirmation had been given by men of position, whom I have now obliged to admit their mistake. Probably, however, the report of the fall of this supposed aërolite has already spread, so that I fear it may be included in lists of historic meteorites.

I may say that the stone had probably fallen or been thrown from one of the roofs of the neighbouring high houses.

December 9 H. J. JOHNSTON-LAVIS

The Rotation-Period of Mars

IN the number of NATURE of November 26 (p. 81), Mr. Proctor mentions one or two points in my investigation of the rotation-period of Mars, requiring correction.

The first is, that I did not use Proctor's final result for the period, but one which he published in 1869, differing 0·02s. from the former. As I intended to determine from the whole series of Mars's drawings the correction of the rotation-period, it was perfectly indifferent what value I adopted in my calculations; the only condition was, the error should not be so great as to cause an erroneous interpretation of the Mars pictures of former years. A difference of 0·02s. in the adopted rotation-period changes the position of the markings in the drawings of Huygens and Hook but 2°·9, so that for my purpose I could adopt Proctor's value of 1869 as well as that of 1873. I chose the former, as it seemed, after a preliminary reduction of Schrœter's observations, to be nearer the truth; but my results would have been absolutely the same had I chosen the second.

The second remark of Mr. Proctor's is the following:—"Prof. Backhuyzen, like Mr. Denning some time since, has taken Kaiser's result uncorrected for the clerical errors—very seriously affecting it—which I detected in 1873." As I have used only Kaiser's *original observations*, and no *result whatever, corrected or uncorrected*, I must conclude that Mr. Proctor has not read my paper very accurately; when he does so, he will see that he is wrong. At the same time he can see that on p. 58 the time of Hook's observations is given, "March 12, 12h. 20m. and 12h. 30m.," and from the indication on p. 55, that there is an integral number of revolution-periods of 24h. 37m. 22·74s. between 1862, November 1, 9h. 55m. mean time Berlin, and 1672, January 1, 22h. 11·0m. mean time Paris, he may conclude, after a slight calculation, that I did not count the years 1700 and 1800 as leap-years. My results are, therefore, free from the errors Mr. Proctor indicated; I hope I made no other.

It seems, however, very difficult to avoid them wholly. Mr. Proctor, for instance, who occupied himself so much with the subject, writes, in the above-mentioned number of NATURE of November 26: "Kaiser counts three days too many in comparing Hook's observation with his own: one day, through a mistake in correcting for change of style and two days (apparently) from counting the years 1700 and 1800 as leap-years." That number of *three* days must be *one* day, for Kaiser indicated as the time of Hook's observations, March 13, 12h. 20m. new style, instead of March 12; by this error the number of days from 1862, November 1, till Hook was one day too small; but, by counting 1700 and 1800 as leap-years, Kaiser added two days too many, so that the total error was one day, and not three. Mr. Proctor's conclusions, based on the latter assumption, are naturally erroneous.

H. G. VAN DE SANDE BAKHUYZEN

Leyden Observatory, December 9

Ventilation

IN NATURE for December 10 (p. 132) I note the suggestion:—"In all new buildings where efficient ventilation is desired, it would be preferable to construct a shaft at one side of, or surrounding the chimney-flue, with an inlet near the ceiling of the room, and the outlet at the level of the chimney-top, so that the air escaping from the room would have its temperature kept up by contact with the chimney, thus aiding the up-draught, whilst the risk of reflux of smoke would be avoided." In building my own house some eight years ago this system was adopted in every room, the outlet over the chandelier being carried across to the side of the chimney of the same room, the two flues being carried up side by side to the chimney stack, each outlet having its own cowl. In practice this has proved a total failure, from the simple fact that the fire-flue is both longer, owing to its starting at a lower level, and that it is also hotter than the other. In the absence of any fire there is a strong upward current in both, but the instant the fire is lighted the upward current in the ceiling ventilator stops, and in a few minutes is reversed, the cold air and collected smoke from the chimney outlet coming in with such force that we have been compelled to make up every ceiling ventilator in the house except one, which, although useless when a fire is lighted, is not a nuisance. Many other experiments in automatic ventilation were tried, so that in case one system failed others might be available, and I regret to say that the only useful remnant of the experiment is the ventilation from the entrance hall, which apparently penetrates with good effect into every room in the house; unfortunately the flue in the entrance hall is one which has a persistent down draught, and we are unable to warm the air in the hall and passages.

There appears to be no rule without exception for automatic ventilation; in one room we have Tobin's ventilators, the opening on the outside facing direct north; these have to be closed always when the room is occupied, as the cold air, after rising a short distance, descends on the heads of the occupants. In another room are four similar shafts built in the wall, the bottom inlets facing west; these shafts are always left full open in the severest weather, the draught being usually downwards and outwards; but why this occurs I cannot form the remotest conception, unless eddies are caused by an adjoining building. There is no doubt that external conditions affect the practical ventilation of any building, and no absolute rules are applicable in every case alike. THOS. FLETCHER

Warrington

Rain at Smyrna

THE telegraph has informed us of a heavy fall of rain at Smyrna on Wednesday, November 25, but few particulars have yet reached us, except some from Capt. Stabb, Corr. Mem. Soc. of Arts. The storm began at six in the morning, and in a few hours 6 inches were registered. When the quay, or embankment, was proposed some years ago, in conjunction with the Council of Public Works I endeavoured to provide an efficient outfall sewer underneath it, but we were defeated by local intrigue. The drainage of Smyrna is worse than in the time of Strabo, by the large additions taken in from the shelving bay. The torrents pouring down from Mount Pagus (the Castle Hill) came through the Turkish quarter, causing the fall of some twenty houses, and washing bodies out of the Turkish and Jewish graveyards. On reaching the lower streets the sewers ceased to act, and cellars, stores, and warehouses were flooded, causing a loss of 50,000*l.* worth of opium, cotton, valonia, and other merchandise, and much damage to private houses. The River Meles overflowed its shallow bed, and reached the Point Railway Station, destroying some market gardens. In the suburb of Bournabat two houses were brought down, and the Cassuba railway embankment was damaged. The storm seems not to have reached beyond Manisa (Magnesia ad Sipylum), over Mount Sipylus, on one side, and Turbalu, beyond the Smyrna plain, on the other. No such inundation has taken place within memory. HYDE CLARKE

The Sea-Mills at Argostoli

WITH reference to the inquiry of your correspondent, Surgeon Lloyd Thomas, in your issue of the 10th instant (p. 129), there is a short paper on this subject by Capt. H. P. Shilston, entitled "On Curious Natural Phenomena in Cephalonia," to be found in the *Transactions* of the Liverpool Geological Association, vol. i. (Liverpool: Henry Young, 1881). The writer describes the inflow of water to the land through crevices in the limestone, as observed by him, and gives an explanation by Prof. Ansted, M.A., F.R.S., who considers that the phenomenon arises from the large amount of evaporation, within range of the district, by which the level of the subterranean stores of water is kept constantly below the level of the sea, notwithstanding the joint supply of rain- and sea-water. O. W. J.

Liverpool, December 12

IN answer to the question of Mr. J. Lloyd Thomas in the last number of your valuable paper (p. 129) respecting the sea-mills of Argostoli, we beg to inform you that we have published, "Die Insel Kephalonia und die Meermühlen von Argostoli, Versuch einer Lösung dieses geophysikalischen Räthsels," von Prof. K. W. M. Wiebel, mit 1 Karte, 3 Skizzen und 5 Holzschnitten, 1873.

Hamburg, December 12 L. FRIEDERICHSEN AND CO.

Friction and Molecular Structure

I SHALL feel obliged if you will kindly allow me to ask any reader of NATURE whether moderate friction can so change the molecular structure of glass as to account for the following fact:—Last night, about twenty minutes after a paraffine lamp had been lighted and had been burning steadily, its glass chimney suddenly burst into small fragments at the exact place at which, about an hour before, I had rubbed it with a piece of brown paper in order to remove soot from the interior. The chimney was thoroughly annealed, having been in constant use for more than three years. The flame was not high; the night was not frosty; the glass was uniformly thin at the place of fracture, which was six inches above the top of the flame, and two inches below the top of the chimney. The part which had not been rubbed is quite uninjured: not even a crack extending into it, while the rubbed part is shattered. EDWARD GEOGHEGAN

Bardsea, December 1

The Resting Position of Oysters—A Correction

MR. J. T. CUNNINGHAM in his letter of November 28 (p. 129), after showing that *Pecten opercularis* must rest on its right valve, goes on to say:—Of *Pecten maximus* I cannot speak with certainty, and therefore leave to Mr. Arthur Hunt the responsibility of stating that there is a difference in respect of position in the two species." So far from my having hinted that any species of Pecten rests on other than the right valve, my letter, to which Mr. Cunningham refers, concludes with the plain statement, "in each case the mollusk rests on the same valve." The point to be noticed is that in *Pecten maximus* the right valve is most convex, and in *Pecten opercularis* the left valve.

A. R. HUNT

Radiolaria

I HAVE recently had the pleasure of finding, in the London Clay, a number of well-preserved specimens representative of several species of Radiolaria, most of which, I have good reason for thinking, differ from any known fossil or recent forms. It was my intention to submit them to the Geological Society during the present month, but circumstances prevent this being done. The delay may lead to an extension of the list, especially if I am fortunate enough to meet with a microscopist kind enough to assist in the examination of material yet untouched. W. H. SHRUBSOLE

Sheerness-on-Sea, December 14

THE CONTINUITY OF THE GERM-PLASMA CONSIDERED AS THE BASIS OF A THEORY OF HEREDITY [1]

THE thoughts developed in this most interesting and important essay were first expressed in a lecture delivered to students of the University of Jena last winter. They were reduced to writing in the spring, and completed for publication in June. The author received Oscar Hertwig's essay on the "Theory of Inheritance," and Kölliker's "On the importance of the Cell-nuclei for the Processes of Heredity," after his manuscript was complete. In the matter of the extreme importance of the nucleus he agrees with both these authors.

As was stated in reviewing here two years ago Prof. Weismann's memoir "On the Origin of the Sexual Cells of the Hydromedusæ," all his memoirs abound in original views and suggestions, which render them of peculiar and widely-spread interest. The present is no exception to the rule. It is intended in this article to give a kind of abstract of the memoir, composed largely of a series of translated passages: for the fuller development of details, the history of the development of ideas on the subject, and controversial matters, readers are referred to the original, which is an octavo of 122 pages.

"How is it," asks the author in commencement, "that in the case of all higher animals and plants, a single cell is able to separate itself from amongst the millions of most various kinds of which an organism is composed, and by division and complicated differentiation to reconstruct a new individual with marvellous likeness, unchanged in many cases even throughout whole geological periods?" The question is a hard one indeed, and the various attempts which have been made to solve it,

1 "Die Continuität des Keimplasma's als Grundlage einer Theorie der Vererbung." Von Dr. August Weismann, Professor in Freiburg i. B. (Jena: Verlag von Gustav Fischer, 1885.)

though most useful as temporary advancements of speculation on the problem, such pre-eminently as Darwin's theory of pangenesis have failed hitherto to dispose of it satisfactorily. It is impossible now to believe that every cell of the organism can give off gemmules which exist at all times in all regions of the body, become collected in the generative cells, and are capable of becoming metamorphosed in regular order back again into the different cells of the organism.

The problem must be considered anew, and the present essay deals not with the entire subject of heredity, but with the fundamental question, How is it that a single cell of the body unites within itself the entire tendencies of inheritance of the whole organism? There are only two physiologically conceivable possibilities by which germ-cells endowed with such peculiar powers as we know them to possess can be produced. Either the substance of the parent germ-cell after passing through a cycle of changes required for the construction of a new individual possesses the capability of producing anew identical germ cells, or *the germ-cells arise as far as their essential and characteristic substance is concerned, not at all out of the body of the individual, but direct from the parent germ-cell.*

It is this latter view which Prof. Weismann holds to be correct, and maintains in the present essay, and which he terms the theory of the continuity of the Germ-plasma. On this theory heredity depends on the fact that a substance of peculiar chemical and even more special molecular composition passes over from one generation to another. This is the "germ-plasma," the power of which to develope to a complicated organism depends on the extraordinary complication of its minutest structure. At every Ontogenesis a portion of the specific germ-plasma which the parent egg cell contains is not used up in producing the offspring, but is reserved unchanged to produce the germ-cells of the following generation.

It is plain that this supposition reduces the question of heredity to one of growth. The germ-cells of all succeeding generations being merely pieces of the same substance as the first, and of the same molecular structure, when nourished under similar conditions, must run through a similar series of stages of development, and yield the same final products.

After combating objections which may be raised to the theory on the score of the heredity of "acquired modifications," it is pointed out that the germ-cells on it appear no longer as a product of the body, at least as far as their essential part, the germ-plasm, is concerned; they are rather to be regarded as something standing opposed to and separate from the entirety of cells composing the body, and the germ-cells of succeeding generations are related to one another as are a series of generations of unicellular organisms derived from one another by a continuous course of simple division into two.

Jäger's and M. Nussbaum's views approached very near those of Weismann; but these authors inferred a continuity of the germ-cells themselves. Such a continuity of cells survives at present in but very few cases. In nearly all instances the generations of germ cells start from the parent, as very minute particles of germ-plasma only, to form, nevertheless, the basis of the germ cells of the next generation.

The author claims for his theory that even should it require to be abandoned in the future, it nevertheless represents a stage in our knowledge of the problem which must be passed through, which must be clearly stated and carefully worked out, whether the future prove it true or false. With this view of it he develops it in three chapters, the first of which deals with the conception of the germ-plasma.

THE GERM-PLASMA.—It now seems established that the only actual carrier of the tendency of heredity is the highly organised nuclear substance; fecundation consists in a union of nuclei; the surrounding cell substance has no immediate participation in the result. E. van Beneden's splendid researches on Ascaris led far towards this conclusion in showing that the nucleus of the egg cell does not fuse in any irregular manner with that of the sperm cell, but that the nuclear loops of these two bodies arrange themselves opposite one another in regular order, two and two, and thus construct the new nucleus, the segmentation nucleus. Van Beneden, as is well known, viewed the two nuclei concerned as half nuclei male and female respectively, the union of which produced an entire nucleus of hermaphrodite nature. Weismann, on the other hand, speaks of "the union of the nuclear substance of the maternal and paternal individual." Strasburger has shown that in the fecundation of phanerogams the nucleus alone of the sperm cell (pollen tube), not the cell body also, enters the embryo sac to conjugate with the nucleus of the ovicell. Strasburger, led by Van Beneden's results, concluded that the occurrence of heredity depends on the transmission of a nuclear substance of specific molecular structure. This specific nucleo-plasma of the germ cell is what Weismann terms germ-plasma. This germ-plasma is, however, by no means identical with Nägeli's idioplasma. The idioplasma, according to Nägeli, is a network which stretches through the entire body, and in fact constitutes the specific molecular basis determining its manner of the body's existence. The general conception of a molecular basis of the organism governing its existence and opposed to the mere nutrient plasma is a fine and original one, and worthy of much merit, but in its detailed development Nägeli's theory cannot now be accepted. Even if the cell bodies are everywhere connected by fine outgrowths in all vegetable and animal pluricellular organisms, as recent research seems to show, the network present is one of nutrient plasma, not of idioplasma, for the determining molecular basis is confined to the nuclei which are not so connected. Moreover, there can be no one single substance such as idioplasma of identical composition permeating the whole body. On the other hand each different kind of cell in each organism must contain its specific kind of idioplasma, or rather nucleo-plasma regulating its peculiar mode of existence.

The author quite agrees with Strasburger in considering the "specific peculiarities of organisms as centred in the cell-nuclei," and also in many points in his statement that "from the nucleus issue forth molecular stimuli into the surrounding cytoplasma, which, on the one hand, govern the processes of change of material in the cells, and, on the other, give to the growth of the cytoplasma conditioned by the nutrition, a certain character peculiar to the species." A valuable confirmation of this position is afforded by A. Gruber's experiment on Infusoria, that, though artificially separated fragments of Infusoria without any portion of the nucleus can live for some time, they never are able to regenerate themselves, whereas fragments containing part of the nucleus always do so. The nature of the nucleo-plasma undergoes a regularly ordered series of changes during ontogeny. The simplest view to take is, that at each division of the nucleus the specific plasma of the nucleus divides itself into two halves, differing in their essential composition, so that each resulting cell-body also, its character being determined by the nucleus, becomes re-fashioned. Thus, in the case of any Metazoon, for example, the two first segmentation spheres would undergo such change that the one would contain only the tendencies of heredity of the endoderm, and the other only those of the ectoderm, and so on throughout. Against such a supposition, however, stands the fact that is observed in instances of indirect division of nuclei during the process of kariokinesis, each mother nuclear loop of the nuclear plate splits exactly in two lengthways into two halves. Each daughter nucleus thus receives exactly the same supply of these, and it would appear as if the two nuclei could not differ, but must be exactly identical. Strasburger, therefore, considering this identity a fundamental fact, concludes that the difference between the two must arise subsequently to their separation as the effect of unlike nutrition. It is urged by Weismann, in antagonism to this view, which would be fatal to his theory, that all that is really proved by the fact is that at every division of a nucleus an equal mass of maternal and paternal nuclear substance passes to form each daughter nucleus, but that it is by no means shown that the quality of the parent nuclear plasma must be identical on both sides. On the other hand, from the effect of the daughter nuclei on their respective cell-bodies, which are most commonly different both in size and texture, it seems proved that they are usually different in quality. As well-marked examples may be cited the polar vesicles. In the case of some Mollusca the egg gives off, by the indirect method of nuclear division, two polar vesicles, one after another, and each of these divides into two. The four polar vesicles perish, whilst the nucleus of the ovum remaining in the yolk combines with the sperm nucleus, and, making use of its own cell body, becomes the embryo. The reason for the difference here must be that the quality of the nucleus of the polar body is different from that of the ovicell.

In accordance with Nägeli's views, then, the molecular structure of the germ-plasma must be so much the more complicated the more complex the organism is which is to be developed out of it: and further, it can be stated that the nuclear substance must become successively less and less complicated as ontogeny proceeds, in proportion as the foundations which yet have to be evolved out of any cell and of which the nuclear plasma is the molecular expression, become gradually less in number. The general nucleo-plasma becoming thus gradually more and more simple in molecular structure, soon loses its capability of reproducing the entire organism; it cannot by any process be metamorphosed back again into the immensely complicated germ-plasma. Only the nucleo-plasma of the original segmentation nucleus is germ-plasma—that is, possesses the structure by the regulating action of which on the process of growth the entire organism can be evolved. In many cases, from the moment of the first division of the ovum into two blastomeres the one blastomere loses the power of reproducing the whole organism out of itself alone, since one resulting blastomere represents the future epiblast, the other the hypoblast. Somatic nucleo-plasma cannot become converted into germ-plasma.

Phylogenetically the germ cells did not originate at the termination of ontogeny, but at its commencement, as is well shown by the conditions existing amongst certain lower chlorophyll containing organisms such as Pandorina and Volvox. The phyletic origin of the first germ cells must evidently be sought amongst the earliest polycellular organisms differentiated by division of labour. In the genus Pandorina of the Volvocineæ no such division of labour has as yet arisen; each spherical colony is composed of exactly similar flagellate cells (each with an eye-spot, chlorophyll contents and pulsatile vacuole) embedded in a common colourless jelly (*homoplastide*). These colonies reproduce themselves alternately by asexual and sexual process; in the latter case the copulating individuals are not yet distinguishable from one another as male and female; in either case every cell of the colony remains as yet a complete unicellular organism capable of separate reproduction. In Volvox, another genus of the same family, a *heteroplastid* condition has been attained and the separation into somatic and generative cells has been effected. The spherical colony consists of two sorts of cells—numerous small flagellate cells and much fewer large germ cells devoid of flagella. The latter alone can effect the production of a new Volvox sphere and can do this in two ways, either asexually (parthenogenetically) or after impregnation by small actively-moving spermatozoa formed out of certain of their own number. Now, as Kirchner has shown, the germ cells become separated off from the somatic cells early in the segmentation of the volvox ovum before the escape of the young heteroplastid from the egg-coverings, which is exactly as should be according to Weismann's views.

Here is proof that there is no intervention of somatic cells in the course of growth between the parent germ-cell and the daughter germ-cells, but that the latter arise directly from the parent germ-cell, and thus the continuity of the germ plasma is established as a fact for the commencement of the phyletic development series. In later times, with increasing complexity of the organism, the time of the separation of the germ-cells became gradually more and more postponed in most cases, and at the present period often occurs quite late at the end of the entire ontogeny. If in the egg of Diptera the first two nuclei which separate themselves by division from the segmentation nucleus of the egg form the reproductive cells, this is a proof that they receive the entire germ-plasma of the segmentation nucleus unchanged.

There are, however, scarcely any theoretical grounds against the supposition that unmodified germ-plasma might be mingled with the nuclear substance of the somatic cells; on the other hand, it would appear *a priori* very conceivable that all somatic cells might contain some unmodified germ-plasma. The fact that a complete Begonia plant with fruit and fertile seed can be grown from a Begonia leaf, whilst in the case of many other plants no such result can be obtained, seems to show that in certain plants the cells, or perhaps only certain cells, of the leaf contain germ-plasma, whilst in others unchanged germ-plasma is not present in the leaves at all, or in very minute quantities only. In the case of the mosses, where almost every cell of the roots, leaves, and axial shoots can become a complete plant, probably all, or nearly all, the component cells must contain an adequate supply of germ-plasma.

The Meaning of the Polar Vesicles.—The egg-cell must contain two kinds of nucleo-plasma or idioplasma, namely, germ-plasma and histogenetic plasma. During its growth it has to accumulate yolk and to form surrounding membranes, in some cases to form a micropyle, and otherwise adapt its cell-body to the production of the future embryo. Therefore, besides the germ-plasm it carries, it requires another kind of specific nucleo-plasma just like every other histologically differentiated cell. This histogenetic plasma cannot be the same as that which subsequently governs the development of the embryo, and which arises from the infinitely complex germ-plasma. As soon as the egg is ripe for fertilisation it is necessary that the histogenetic plasma should be got rid of, in order to leave the germ-plasma free to act, and the extrusion of the polar bodies is the removal of this *ovogenous* nucleo-plasma. This is an entirely new theory as to the significance of the polar bodies, and directly opposed to all those which would see the extrusion of a male element in the act.

In the case of the male sperm-cell, also, two kinds of nucleo-plasma are present—germ-plasma and spermogenous nucleo-plasma. As soon as the spermatozoon is ripe, the spermogenous nucleo-plasma is cast off as the equivalent of the polar body. Strasburger has lately described a large number of instances amongst plants of different groups, in which processes resembling the extrusion of polar bodies accompany the ripening of the generative elements of both sexes. And it is probable that similar conditions will in time be discovered to exist in other plants.

On the Nature of Parthenogenesis.—The fact of the formation of the polar bodies, considered in the light of the theory of the sexuality of the germ cells, has been freely made use of to explain the occurrence of parthenogenesis. Balfour suggested "that the function of forming polar cells has been acquired by the ovum for the express purpose of preventing parthenogenesis." Weismann naturally cannot agree with this view, since he regards the extrusion of polar bodies merely as the removal of the ovogenous or spermogenous nucleo-plasma. At the time his memoir was written there were no instances in which it had been ascertained with absolute certainty whether polar vesicles are formed or not in the case of ova about to develop parthenogenetically; but in a postscript at the end of the memoir he is able to announce that he has discovered that in the case of parthenogenetic summer eggs of the Daphnidæ a polar vesicle of distinct cellular structure occurs. This is sufficient proof of the incorrectness of the older theory, and he further adduces the fact that in the case of the honey-bee the same identical egg can be made to develop either after fertilisation or parthenogenetically, according to the act of the queen, showing that the parthenogenetic and sexual eggs are of the same essential nature. The difference between the two must lie in the quantity of germ-plasma which they respectively contain. In order that the segmentation nucleus of the ovum may proceed to the process of ontogenesis, it must possess a certain mass. Even amongst higher vertebrates it is known that an unfertilised egg may occasionally go through the first few stages of segmentation, then, however, always failing through lack of the requisite power.

When impregnation takes place and the substance of the nucleus of the sperm-cell becomes added to that of the ovum, the combined mass of germ-plasm becomes powerful enough to carry through all the stages of ontogeny to the end. In the case of certain animals where the ovum remains unfertilised, and thus unchanged after the extrusion of the ovogenous nucleo-plasma, if a special supply of nourishment reaches its germ-plasma, this increases in amount by growth, and thus attains the mass requisite to start the ontogenetic process, with the result that parthenogenetical development takes place. In the ordinary sexual process it is the sudden doubling of the mass of the nucleus by the copulation that starts the segmentation of the ovum. It is the increase of the mass of the nucleus which gives the stimulus to segmentation, the disposition to which was already there before. The difference between eggs requiring fertilisation, and those not requiring it supervenes after the ripening of the egg and the extrusion of the ovogenous plasma. The phyletic inheritance of the capability of parthenogenetic development rests on a modification of the power of growth of the egg nucleus.

More than ten years ago Weismann expressed the conviction that "the physiological value of the sperm-cell and egg cell are identical," and now that the body of the egg cell can hardly have ascribed to it a higher value than that of a common nutrient ground for the two nuclei during the act of impregnation, this position seems a very secure one, Strasburger fully agrees, and states that "Sperm-nucleus and egg-nucleus do not differ in their nature." If it were possible to introduce by artificial means into any egg, immediately after the change of the germinal vesicle into the egg-nucleus, the egg-nucleus of another egg of the same species, it is probable that the two nuclei would copulate just as if a ripe sperm-nucleus had penetrated into the egg in the usual way, and a direct proof would thus be given that the egg and sperm-nucleus are in fact identical. The technical difficulties are too formidable to permit of this experiment being made, but a partial confirmation is afforded by Von Berthold's discovery that in certain algæ Ectocarpus and Scytosiphon, not only a female, but also a male parthenogenesis occurs. Further, the occurrence of conjugation must be regarded as a proof of the correctness of this view. There can scarcely be any further doubt that conjugation is the sexual reproduction of unicellular organisms. Amongst these usually the two conjugating cells are externally absolutely alike, and probably they are so internally also, but there are some low forms, such as Volvox, where a difference between the two is already fully established, huge egg shells and minute zoosperms being produced. The identity of the sperm nucleus and egg nucleus here insisted on only regards their essential fundamental structure and composition; each is in certain finer details necessarily peculiar, as transmitting the idiosyncracies of its own parent stock.

H. N. MOSELEY

THOMAS ANDREWS, F.R.S.

DR. ANDREWS, whose death we announced a fortnight ago, was a native of Belfast (born December 19, 1813), and spent his whole life there. His father was a linen-merchant, in good position; and he received his early education at the Academy and at the Royal Academical Institution of Belfast. Thence he went to Glasgow, where he studied under Dr. Thomas Thomson, the well-known Professor of Chemistry, and learned practical work in his laboratory. He had, next, a successful undergraduate career in Trinity College, Dublin; where he distinguished himself in Classics as well as in Science. Having spent some time in Paris, in the laboratory of Dumas; and having obtained his Medical Degree in the University of Edinburgh, in 1835; he devoted himself to medical practice in his native town. In this he was highly successful; but he continued to devote his leisure, small as it was, to scientific research; publishing numerous papers on chemical and physical subjects. To these we will recur, but it is noteworthy that in 1844 he received one of the Royal Medals, in the gift of the Royal Society, for his purely scientific discoveries, before he finally gave up professional practice. He was the first lecturer appointed to teach Chemistry in the Royal Belfast Academical Institution, and he resigned this post, as well as gave up practice, when appointed in 1845 to the Vice-Presidentship of the "Northern College," now Queen's College, Belfast. The Presidents and Vice-Presidents of these new Irish institutions were appointed some years before the Colleges were opened, or the Professors elected, in order that the Government might have their advice and assistance in maturing the whole scheme. Andrews was thus associated with another justly-distinguished Irishman, Sir Robert Kane; and it is mainly to their labours and foresight that the Queen's Colleges, when at last opened, appeared before the world in full working order.

It had been understood from the first that Andrews was to be the Professor of Chemistry in Belfast; but, when the time for appointing Professors arrived, he was required (as a matter of form, merely) to produce a few Testimonials. These he obtained at once, in the highest terms, from such men as Thomas Graham, Humphrey Lloyd, MacCullagh, &c., and they need not be given here. But it may be interesting to show, as briefly as possible, the opinions of two of the greatest of foreign chemists. Liebig wrote (November 10, 1845) as follows:—"Ich hege die volle Ueberzeugung dass der Platz um den Sie sich . . . bewerben, keinen würdigern Besitzer finden dürfte. Sie haben viele Jahre hindurch mit den grössten Schwierigkeiten zu kämpfen gehabt, um der warmen Neigung welche Sie für die Naturwissenschaften hegen Nahrung zu geben, und weit entfernt dass Ihr Muth und Eifer dadurch gelähmt worden wäre, haben Sie durch Ihre letzten wichtigen Arbeiten über die Wärme bey chemischen Verbindungen dargethan, dass die Beschäftigung mit der Wissenschaft ein Bedürfniss ihres Geistes ist." Dumas (November 29, 1845) wrote:—"Vos titres à la nouvelle fonction à laquelle vous aspirez sont si clairs et si évidents que je ne concevrais guère que vous n'y fussiez point appelé . . . mais, tout en enseignant la chimie, n'oubliez pas que vous comptez au nombre des physiciens distingués de votre pays." The rest of this letter is not personal, but refers to the impossibility of separating chemistry from physics, and to the important aid which each of these sciences constantly obtains from the other.

Andrews was as successful in his Professorship as he had formerly been as a Practitioner. He soon gathered large classes, alike for general chemistry and for practical laboratory work. All his spare time, for the greater part of every working day, was spent in his private laboratory. Here he delighted to receive his scientific friends, and to engage eagerly in conversation with them while his hands were busy with the steady, deliberate construction or adjustment of apparatus for his next research. His habits were of an extremely temperate, almost abstemious, character. From his early breakfast, to his somewhat late dinner-hour, he never partook of either food or drink: and used to say that a man required only two meals a day. It is to be feared that his persistence in this habit in his later years tended materially to reduce his strength.

He was elected to the Royal Society in 1849. In 1852 (at Belfast), and again in 1871 (at Edinburgh), he presided over the Chemical Section of the British Association. He was President of the Association in 1876 (at Glasgow), having declined the appointment in a former year in consequence of the state of his health. He was a corresponding member of the Royal Society of Göttingen and an Honorary Fellow of the Royal Society of Edinburgh. He received honorary degrees from various Universities. But he valued this class of distinctions simply as tokens of the esteem and good wishes of the donors; and in the somewhat delicate matter of a civil title he shared the opinion, and followed the practice, of his cherished friend Faraday. In 1879 he resigned his appointments in Queen's College, and thenceforth led a very retired life, though still vividly interested in the progress of science, till his death on November 26 last.

The only purely literary works of Andrews, so far as the writers of this notice are aware, were his two extremely thoughtful and learned *Chapters of Contemporary History*. The first, entitled *Studium Generale*, was published in 1867, when attempts were being made to cripple the usefulness of the Queen's Colleges. The reasons for the appearance of the second, published in 1869 with the title *The Church in Ireland*, are still too painfully prominent to require special mention.

Dr. Andrews married, in 1842, Jane Hardie, daughter of Major Walker, of the 42nd Highlanders. He is survived by his widow, by three daughters, and by two sons, the elder of whom is Major in the Devonshire Regiment, and the younger a member of the Irish Bar.

His first published paper on a chemical subject is on the composition of the blood of cholera patients. He showed that it differed from normal blood only by having a smaller proportion of water. Much more important both in itself and as showing the bent of his mind to the borderland between Chemistry and Physics is a paper on galvanic cells with strong sulphuric acid as the exciting liquid. The question is of course really that of the electrolysis of strong sulphuric acid, and Dr. Andrews showed that the composition of the gas given off at the cathode varies in a remarkable manner with the temperature. This is quite in accordance with what we now believe as to the constitution and dissociation of strong sulphuric acid, but at the time the paper was written nothing was known which could lead any one to suspect such a variation.

We now come to one of his great works—the determination of the heat evolved during chemical action. In three series of investigations he determined the heat given out in the formation of neutral, acid, and basic salts, by the action of acid on base; in the displacement of one metal in a salt by another; in the formation of oxides; and in the formation of chlorides. In this great research we see the character of the man, his clear view of what was to be observed, his distinct recognition of the sources of experimental error, and the simple but effectual means he took to get his results free from the effects of such disturbing causes. Especially worthy of note is his use of solutions so dilute that further addition of water produced no sensible thermal change.

The well-known experiments of Favre and Silbermann were published not long after Andrews' first papers on this subject. It is interesting to notice that where these observers differ from Andrews, subsequent investigations, particularly those of Berthelot and of Thomsen, have shown that Andrews was right.

In 1855 Andrews communicated to the Royal Society a paper of great importance and interest on Ozone. This remarkable substance had been studied by Schönbein, its discoverer, Marignac, De la Rive, Berzelius, Williamson, Fremy and Becquerel, and Baumert, but its nature still remained a mystery. Is ozone always the same thing, or are the ozone of electrolysis, that of the electric machine, and that formed during the slow oxidation of phosphorus, different bodies very like one another in properties?

Some experiments seemed to show that ozone contained nothing but oxygen, others that it was an oxide of hydrogen containing a larger proportion of oxygen than water does. The question was exactly of the kind to attract Andrews and to call out his peculiar powers of investigation.

By a series of experiments remarkable for simplicity and delicacy, and perfect adaptation to the purpose in view, he proved that "ozone, from whatever source derived, is one and the same body, having identical properties and the same constitution, and is not a compound body, but oxygen in an altered or allotropic condition."

The investigation into the nature of ozone was continued by Andrews and Tait, and the results published in their paper *On the Volumetric Relations of Ozone and the Action of the Electrical Discharge on Oxygen and other Gases* (*Phil. Trans.*, 1860). These results led directly to the theory of the constitution of ozone now universally held; indeed that theory is distinctly stated by Andrews and Tait, although not further discussed on account of its supposed improbability.

Among smaller works we may mention the discovery of minute particles of metallic iron in various rocks, particularly basalts.

None of his chemical papers can be read without some new idea being communicated to the reader, however well acquainted he may be with the subject.

The investigation, however, by which Andrews is, and will continue to be, best known, was that *On the Continuity of the Liquid and Gaseous States of Matter* which formed the subject of the Bakerian Lecture in 1869, and again in 1876.

One of the earliest of Faraday's researches was devoted to the liquefaction of gases, and he succeeded with all but a few, which were in consequence, till very recently, distinguished as "non-condensable." But he expressed the conviction, founded on experiment, that even these could be liquefied by the conjoint action of sufficient pressure and sufficient reduction of temperature.

Another extremely ingenious experimenter, Cagniard de la Tour, had approached the subject from the opposite side; and had shown that liquids, such as water and sulphuric ether, could be changed into something which was certainly not liquid, by sufficient rise of temperature without any great increase in volume.

Regnault, also, had measured with his unrivalled precision the compressibility of various gases; and had called attention to the curious differences which they show in their modes of divergence from Boyle's Law. And Natterer, by employing pressures of some thousands of atmospheres, had arrived at other startling results.

The whole subject was in that chaotic state which naturally precedes the advent of the Kepler who is to marshal, under a few general statements, each intrinsically simple, the mass of apparently irreconcilable phenomena.

Andrews' classical researches completely effected this simplification. Guided by the results of Regnault, he selected carbonic acid as the substance whose behaviour was made the subject of exhaustive study through wide ranges of temperature and of pressure. He devised an extremely ingenious form of apparatus for the purpose, had the coarser metallic parts constructed under his own eye by a remarkably skilful mechanic; and himself made and calibrated the glass portions, purified with great care and skill the gas to be operated on, and finally fitted up the whole with unwearying patience.

The simpler and more prominent results of this splendid research may be briefly summed up as follows:—

(*a*) When carbonic acid is maintained at any temperature whatever *above* 30°·9 C., it cannot even in part be condensed into liquid by any pressure however great.

(*b*) If the temperature be *below* 30°·9 C., the gradual increase of pressure ultimately leads to liquefaction; but the pressure of the vapour in presence of the liquid is less as the temperature is lower.

(*c*) A cycle of operations, in Carnot's sense, can be performed on liquid carbonic acid in such a way that, during the first stage of the expansion we have optical proof of the existence of liquid and gas side by side in the same vessel; while on compressing again at a higher temperature, and finally cooling down to the original temperature and volume, the whole contents are once more liquid; though at no stage of the latter part of the operation is there any appearance of the joint presence of two different states of matter. It is this fact which suggested the title of the paper.

(*d*) The key to the explanation of observed deviations from Boyle's Law was furnished by his study of the isothermals of carbonic acid at temperatures not much above 30°·9 C. For Andrews's measurements show that the product of pressure and volume (which, by Boyle's Law, should be constant) diminishes with volume to a minimum, and thereafter rises rapidly as the volume is farther diminished.

Many other valuable results, such as the great compressibility of liquid carbonic acid, especially at temperatures near to 30° C.; the alteration of surface-tension of the liquid, and of its angle of contact with glass, as the temperature is raised, &c., appear as mere side-issues of this investigation.

The discovery of this Critical Temperature, or Critical Point, soon led to the liquefaction (and in certain cases even to the solidification) of the gases which had been called "non-condensable." Andrews' work had supplied all the necessary hints for the adaptation of his apparatus to such a purpose. In fact the main requisites were (1) to work on a larger scale, (2) to employ very low temperatures, and especially (3) to provide a means of ensuring *sudden* relaxation of pressure. The work of Pictet, Cailletet, v. Wroblewski, Amagat, &c., on this subject, followed as a natural and immediate consequence of that of Andrews.

The writers have, like many others, seen and admired the confident manipulation, by Andrews, of wide sealed tubes, half full of liquid carbonic acid; how he, knowing the soundness of his own glass-blowing, boldly heated such tubes in the flame of a Bunsen lamp, till the liquid entirely disappeared, and pointed out with eager enjoyment the extraordinary phenomena presented as the contents cooled nearly to the critical temperature. The whole tube seemed, for a short time, to be filled with a substance presenting, to an exaggerated degree, the appearance of a mixture of water and alcohol before diffusion has sensibly operated.

We have spoken of Andrews's remarkable skill in manipulation, and of his unwearied patience. But even these were eclipsed by the perfect calmness with which, though on the very verge of an important discovery, he attended to every point of minute and laborious detail; so that his first successful experiment was as exactly carried out and recorded as was its future repetition. This was all the more remarkable in that he was usually, especially in public, a man of a highly nervous and excitable temperament.

An excellent French and German scholar, he kept himself always well acquainted with the most recent progress of science, whether chemical or physical. He constructed his own dividing-engine for the calibration of the exquisite thermometers which he made for his researches on heat; and his air-pump (in which he took special delight) was furnished with numerous valuable improvements all devised by him for particular applications. His laboratory books were models of ample, but not superfluous, detail.

He was, personally, a man of simple unpretending manner; conscientious almost to an extreme, but thoroughly trustworthy and warm-hearted; an excellent example of the true Christian philosopher.

NOTES

We regret to announce the death of Mr. Alfred Tribe, the well-known chemist, on November 26, at the age of forty-six years. We defer to next number a notice of Mr. Tribe's career.

A meeting of the subscribers to the testimonial to Dr. H. Woodward, F.R.S., for twenty-one years editor of the *Geological Magazine*, was held on the 15th inst., at the rooms of the Geological Society, Burlington House, when Prof. T. G. Bonney (Pres. Geol. Soc.) presented to that gentleman, on behalf of the subscribers, a silver tea and coffee service and a cheque for 253*l*. On making the presentation, Prof. Bonney addressed Dr. Woodward, referring to the invaluable services he had rendered to science during the twenty-one years he has had charge of the *Geological Magazine*. In replying, Dr. Woodward referred briefly to the career of the *Magazine* and its predecessors, to the many distinguished men that had been connected with them, and to the period of remarkable scientific interest thus covered. Over 200 names are on the list of subscribers to the testimonial.

The 10th instant was a red-letter day at the French Institute. M. Bertrand was introduced as member of the Académie Française, and read an address which, according to custom, was devoted entirely to thanking his brother Academicians and to eulogising his immediate predecessor, M. Dumas. The address was acknowledged by another oration from M. Pasteur, who after having summarised the life of M. Bertrand, gave a long and interesting account of the career of M. Dumas. Great enthusiasm prevailed throughout the proceedings, and the hall was crowded.

The number of patients in the special clinic of M. Pasteur is increasing daily, several arriving from foreign countries. No less than forty were inoculated on December 14 before the Minister of Agriculture, who acknowledged the services rendered by Pasteur to humanity. Among the patients is an officer of the Czar's body-guard, just arrived from St. Petersburg.

A biography of the late Sir William Siemens is being prepared, at the desire of the executors, by Dr. William Pole, F.R.S., Hon. Secretary of the Institution of Civil Engineers, and author of the "Life of Sir William Fairbairn, Bart." Dr. Pole will be grateful for the loan of any of Sir William's letters, or for any information of importance. Address, Athenæum Club, S.W.

On Saturday, last week, the rainfall at the Ben Nevis Observatory amounted to 4·991 inches, and on the Sunday following to 3·604 inches, there having thus fallen on these two days fully eight inches and a half. During this time the wind was westerly and north-westerly, force 2 of Beaufort's scale, with occasional squalls. On the Monday the wind was still westerly, and though no rain fell from 2 a.m. to 10 a.m., the rainfall for the twenty-four hours was 1·225 inch.

THE death is announced of Xavier Ullesberger, the well-known palæontologist, at Ueberlingen, on the Lake of Constance, at the age of seventy-nine. His special distinction is the discovery of the lacustrine villages in the Lake of Constance, at Nussdorf, Maurach, Uhldingen, and Sipplingen. The extensive collection of Celtic and prehistoric objects which he got together in the course of his researches is preserved at Stuttgart.

THE death of Mr. Edwin Ormond Brown, Assistant-Chemist to the War Department, occurred on Saturday last. Mr. Brown had been engaged in the chemical establishment at the Royal Arsenal, Woolwich, for about thirty years, and has been instrumental in the improvement of gun-cotton and other explosives, besides rendering useful services in other matters.

THE Earl of Iddesleigh gave a very sensible address the other evening to the students of the Exeter Science Classes, of which he is the patron. He spoke of the rapidly growing feeling in favour of scientific education, and of the results it had already accomplished for the individual and the nation. After referring to misconceptions as to what technical education really meant, the Earl said:—"There is no doubt that by technical education you may mean one of two things. You may either mean an advance in the teaching of the scientific principles on which industrial processes depend, or you may mean the teaching of those processes practically and illustratively in the school rather than in the workshop. There is a very great difference between these two things. It may be desirable at times to give a certain amount of instruction in schools of a practical character, but that must not be pushed very far. It must be borne in mind that technical teaching, to be of real service, must be obtained in the course of work itself in the workshop. But with regard to the principles on which the processes of manufacture rest, those principles can only be taught in the schools, and it is to the development of those principles that we ought to pay most attention. That is the advantage which in schools of this kind you get. The study of pure and unapplied science is interesting to every one, but it does not at once appear that it has a direct bearing on the pursuits and callings of those who indulge in it. I daresay you may have heard the old question put, 'What is the use of any purely scientific discovery?' For answer another question was asked, 'What is the use of a baby?' The question is, What will it turn out to be? How will it be brought up, and how will it be brought into play?" The Earl of Iddesleigh then quoted the following passage from Prof. Huxley:—"'If you could, in the first place, keep your elementary scholars long enough to put them through a fair training in the principles of which the application lies in the special direction of metallurgy, and, secondly, if you could secure that they should acquire a special proficiency in such subjects, I think that would be a most admirable thing to do; but I thing the way it would work out under the present conditions would be this, that you would have special classes set up to grind young fellows without any knowledge of principles in that which would be no better than a rule of thumb. I do not believe that that would be of the smallest good. I believe, on the contrary, that it would do endless harm, because there would be a sort of pre-supposition that these young men really had the knowledge which would enable them to advance and improve their methods, whereas in reality the knowledge they possessed would be nothing more than a little of the ordinary *technique* of their business varnished over with scientific phraseology.' What you want," the Earl said, "is what Prof. Huxley says you want, as far as you can get it—the education to turn upon the principles on which the true science is based, as distinguished from the application of the science. Having got that, you will find that there will be abundance of opportunity to apply to the arts which you are about to prosecute the principles you have learnt. These principles I believe to be the main secret of what is sometimes called scientific, and sometimes called technical, education."

THE Royal Geographical Society will hold a special meeting on Monday, December 21, to welcome Major Greely, the distinguished Arctic explorer, and hear him tell the story of his work and adventures in the Polar Seas.

THE Natural History Museum at Vienna has just been presented with 708 skulls collected through a series of years by Dr. Weissbach, who was for a long time director of the Austro-Hungarian hospital at Constantinople, and was a very distinguished anthropological investigator. Of the collection 195 are pure Turkish skulls, 131 Greek, 96 Servian or Croat, 48 Hungarian, 43 Armenian, 29 old Byzantine. There are also skulls of Maronites, Albanians, Koords, Asiatic Jews, &c.

AS No. 1 of the Special Papers of the Alabama Weather Service we have an interesting record of the weather from 1701 to 1885, by Capt. W. H. Gardner, of Mobile.

SCIENCE has, on the whole, no reason to quarrel with the results of the General Election. Sir Lyon Playfair is returned by a large majority for one of the divisions of Leeds; and Sir John Lubbock again takes his seat unopposed for London University. A new and very important additiou to the ranks of scientific men in Parliament is Sir Henry Roscoe, who was elected after a sharp contest for South Manchester. His election is striking in one way, for he is the only Liberal returned in the six divisions of Manchester. Sir Edward Reed retains his former seat for Cardiff, but Prof. Rücker, of the Yorkshire College, failed to win a place. The medical profession is even more strongly represented than it was before. Dr. Foster, Professor of Medicine in the Queen's College, Birmingham, was elected for Chester, and Mr. Erichsen, the eminent surgeon, is a candidate for Edinburgh and St. Andrews Universities. Even amongst the followers of Mr. Parnell, there are members of the medical profession. Mr. Ernest Hart, however, has been rejected by Mile End.

WE have received the last part (vol. i. part 5) of the *Proceedings* of the Perthshire Society of Natural Science for the session 1884–85. It contains a series of museum notes, by Dr. Buchanan White, the indefatigable President for the current year, which are intended to form a guide to the museum subsequently; two papers on the comparative anatomy of the teeth, by Mr. James Stewart; the diatoms of the Tay, by Dr. Trotter; shells—their structure, growth, and use, by Mr. Coates; the climate of the British Islands, with special reference to Perthshire, by the Rev. A. Campbell; the native timber trees of Perth, by Mr. Lindsay; and some minor contributions. The presidential address is devoted to the exceedingly practical subject of explaining why the growth of the museum renders considerable increase of space necessary, and the cost of the consequent building operations. An appeal is also made for further specimens for the Perthshire collection of natural history—an appeal which we trust may meet with adequate response, for apart from the general public benefit of local museums as centres of education throughout the country, they are of universal scientific importance when they are made the depositories of specimens of the natural history, past and present, of their respective neighbourhoods. But to be of the fullest value in this respect, they must be made as complete as possible.

MESSRS. MACMILLAN AND CO. will publish next week the Essex Field Club Report on the East Anglian Earthquake of April 22, 1884. This Report has been drawn up by Prof. Raphael Meldola and Mr. William White, and will contain maps and several illustrations.

THE jubilee volume of the Statistical Society will shortly be published by Mr. Stanford, of Charing Cross. It will contain the proceedings of the jubilee meeting of the Society held in June last, and will comprise valuable papers by the President, Sir Rawson W. Rawson, Dr. F. J. Mouat, M. Levasseur, and Prof. Neumann-Spallart, at whose initiation the International Statistical Institute was then founded.

FRESH earthquake shocks have been felt in the district round M'sila during the last week and principally on Saturday, December 12. They have also been felt at Bordj-ban-areridj and Setif. The new road from Setif to Bordj has been cut by rocks falling from the surrounding mountains. A bridge has been destroyed and a railway station demolished. It is impossible up to this time to state whether the commotion originated in the Atlas or in the Hodna region, where M'sila is placed, not far from a large Sebbha, which, although almost dry in summer-time, contains a large quantity of water in rainy periods. Official documents will be sent to the Paris Academy of Sciences as soon as collected, but it is feared they will lack precision; no seismograph, so far as our knowledge goes, having been established in Algiers.

ADVICES from Smyrna in Asia Minor to November 25 state that a series of earthquakes, commencing on the 13th, had up to that time been felt at Denizlu in the interior, about 200 miles to the east. These disturbances were slight, but accompanied with subterranean noises.

WE are glad to see that the extremely valuable meteorological observations which were made at Sagastyr, the Arctic Station in the Delta of the Lena, during the years 1882 to 1884, are already being published. The last issue of the *Izvestia* of the Russian Geographical Society contains a preliminary report, by M. Yurgens, and several meteorological tables, namely, the observations in full, from September 1, 1882, to September 1, 1883, of the barometer, temperature of the air, of the surface of the soil and of the snow, and of the soil at a depth of 1 metre, the relative humidity, force of wind, and nebulosity; and the monthly averages of the above for each hour of the day. The magnetical observations for the same period are being calculated, as also those for 1883 and 1884. The whole, together with observations of the temperature of the soil at depths of 80 and 160 centimetres, temperature and density of water, tides, and auroræ will be published in a separate form. A map of the Delta of the Lena, based on new surveys, and a plan of the station accompany the report of M. Yurgens, which is very interesting, as it contains many details as to the life at the station, and varied information as to the Delta, and the excursions made during both summers. It is worthy of notice that the meteorologists of the station, although lost amidst tundras in the 73rd degree of latitude, were not so secluded from the world as might have been supposed. They received letters regularly from Yakutsk, together with newspapers and reviews, which reached them four months after their publication at St. Petersburg—a delay which is not so great if it be taken into account that letters take nearly one month to reach Irkutsk, the capital of Eastern Siberia. As to the frozen mammoth whose remains were explored by Dr. Bunge, only pieces of bones and traces of the contents of the stomach were found and brought to St. Petersburg.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀), two Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Monte Video, presented by H.R.H. the Prince of Wales, K.G.; two West Indian Agoutis (*Dasyprocta cristata*) from West Indies, presented by T.R.H. Prince Albert Victor and Prince George Frederick of Wales; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. Jan Smidt; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Miss Ethel Rodger; two Tigers (*Felis tigris*) from Hyderabad, presented by the Nawab Salar Jungh Bahadur; a Cheetah (*Cynælurus jubatus*) from Afghanistan, presented by the Nawab Mahomed Hassan Ali Khan; a Tiger (*Felis tigris*).

OUR ASTRONOMICAL COLUMN

BRIGHT LINES IN STELLAR SPECTRA.—Mr. O. T. Sherman has continued his researches on the spectra of γ Cassiopeiæ and and β Lyræ, and announces in the *American Journal of Science* for December the discovery of no fewer than fifteen in the spectrum of the former star, and seventeen in that of the latter. The lines seen in γ Cassiopeiæ are as follows:—Hα, λ 6356, 6160, D_3, λ 5840, 5557·5, 5422, 5309·8, 5167·5, 4990, Hβ, λ 4623, Hγ, λ 4180, and Hδ, bright lines; and λ 6280, 5760, 5020, 4920, 4673·5, and 3993, dark lines. The bright lines agree closely in position with the principal lines observed by Prof. Young in the spectrum of the chromosphere.

Mr. Sherman has also examined a large number of other stars, and "*in each case* many or few bright lines have been seen, lines, so far as I know, formerly unsuspected." It is clear, if Mr. Sherman's observations can be satisfactorily confirmed, that we have here a most important discovery; but looking to the fact that these stars have probably been frequently observed by experienced spectroscopists without any bright lines being detected in them, whilst a false appearance of bright lines is readily produced in stellar spectra under certain circumstances, it would appear hazardous to accept Mr. Sherman's result without further evidence.

PHOTOMETRY OF THE PLEIADES.—A valuable memoir (*Mémoires de l'Academie Impériale des Sciences de St. Pétersbourg*, vii. série, tome xxxii. No. 6) by Herr Ed. Lindemann of Pulkowa, "On the Magnitudes of Bessel's Stars in the Pleiades," has recently reached us. A special point of interest lies in the fact that Profs. Pickering and Pritchard have likewise determined the brightness of many of these stars with their respective photometers, each assuming the magnitude of Merope, to which the other stars of the group are referred, as 4·22. Herr Lindemann has also adopted the same magnitude for Merope, which he has used as his standard star. He also employed, as reference stars, Celæno and Anon 32, the magnitudes of which he had determined to be 5·27 and 6·51 respectively. The stars, fifty-two in number, were each observed on two separate nights, only one star of the fifty-three observed by Bessel proving too faint for Herr Lindemann's telescope of five inches aperture. Comparing his own results with those of Profs. Pickering and Pritchard, Herr Lindemann finds, on the whole, a very gratifying agreement; twenty-five stars observed by Prof. Pickering showing a mean excess over the Pulkowa observations of 0·04 of a magnitude, and thirty-three stars observed by Prof. Pritchard giving a mean excess of 0·05. Prof. Pritchard's later observations give a yet smaller difference, viz. 0·01 of a magnitude. When it is remembered that the three photometers employed—Herr Lindemann using a Zöllner photometer—differed entirely in principle, construction, and method of employment, this close agreement would seem to indicate that each may be relied upon with very considerable confidence, when the differences of stellar magnitude determined by their means are not very great. The stars Nos. 1, 4, 21, 31, and 33 would appear to be variable, and possibly two others likewise. Pogson's scale has been employed for the conversion of the logarithm of the light of the star into magnitude.

FABRY'S COMET.—The following elements and ephemeris have been computed for this comet by Dr. H. Oppenheim:—

Perihelion Passage, 1886 March 9·7944 Berlin M.T.

$$\left.\begin{aligned}\omega &= 132^\circ\ 36'\ 19''\\ \Omega &= \ \ 32\ \ 17\ \ 32\\ i &= \ \ 47\ \ 18\ \ \ 0\end{aligned}\right\}\text{Mean Eq. 1885·0}$$

$$\log. q = 9·69654$$

Errors of the middle observation :—

$\delta\lambda = -8''$ $\delta\beta = -2''$.

Ephemeris for Berlin Midnight

1885	App. R.A. h. m. s.	App. Decl.	Log. Δ	Brightness
Dec. 20	23 59 57	+20 43·1	0·0837	1·4
22	56 49	44·3		
24	53 52	46·2	0·0844	1·5
26	51 5	49·0		
28	48 29	52·6	0·0849	1·6

The brightness on December 1 is taken as unity. The above elements differ considerably from those published by Dr. S. Oppenheim in the *Vienna Circular*, No. lvi., but appear to represent the observations better.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, DECEMBER 20-26

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 20

Sun rises, 8h. 5m. ; souths, 11h. 57m. 59·2s. ; sets, 15h. 50m. ; decl. on meridian, 23° 27′ S. : Sidereal Time at Sunset, 21h. 48m.

Moon (Full on Dec. 21) rises, 15h. 17m. ; souths, 23h. 5m. ; sets, 6h. 58m.* ; decl. on meridian, 17° 48′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 36	11 45	15 54	20 58 S.
Venus	10 47	15 17	19 47	17 41 S.
Mars	22 46*	5 25	12 4	7 2 N.
Jupiter	0 22	6 23	12 24	0 38 S.
Saturn	16 19*	0 28	8 37	22 29 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Occultations of Stars by the Moon

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image °	°
20	γ Tauri	4	4 11	near approach	44	—
20	B.A.C. 1526	6	17 6	near approach	151	—
21	111 Tauri	5½	5 6	5 56	113	325
21	117 Tauri	6	6 35	7 6	77	353
21	B.A.C. 1930	6½	17 46	18 37	38	253
25	ξ Leonis	6	3 55	5 5	80	276
26	48 Leonis	6	6 50	7 48	123	258

Phenomena of Jupiter's Satellites

Dec.	h. m.		Dec.	h. m.	
21	1 35	II. occ. reap.	22	5 54	I. tr. egr.
21	5 17	I. ecl. disap.	22	6 30	III. occ. reap.
22	1 34	III. ecl. reap.	23	3 14	I. occ. reap.
22	3 35	III. occ. disap.	24	0 22	I. tr. egr.
22	3 38	I. tr. ing.	26	7 11	II. tr. ing.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Dec.	h.	
21	—	Sun at greatest declination south ; shortest day in northern latitude.
22	5	Saturn in conjunction with and 3° 58′ north of the Moon.
26	11	Saturn in opposition to the Sun.

Variable Stars

Star	R.A. h. m. s.	Decl. ° ′		h. m.	
β Lyræ	18 45 50	33 13·8 N.	Dec. 25,	0 0	*m*
R Lyræ	18 51 50	43 47·7 N.	,, 26,		*m*
χ Cygni	19 46 9	32 37·4 N.	,, 26,		*M*
η Aquilæ	19 46 37	0 42·7 N.	,, 21,	17 0	*M*
δ Cephei	22 24 54	57 49·6 N.	,, 23,	4 0	*M*
,,			,, 26,	23 0	*m*
R Andromedæ	0 17 58	37 56·4 N.	,, 23,		*M*
Algol	3 0 41	40 30·7 N.	,, 22,	3 51	*m*
,,			,, 25,	0 40	*m*
ζ Geminorum	6 57 17	20 44·3 N.	,, 23,	19 0	*M*
δ Libræ	14 54 50	8 3·7 S.	,, 22,	19 5	*m*
,,			,, 25,	2 56	*m*

M signifies maximum ; *m* minimum.

Objects with Remarkable Spectra

Mr. O. T. Sherman, of Yale College Observatory, has recently called fresh attention to the spectra of γ Cassiopeiæ and β Lyræ, as he finds no fewer than seventeen bright lines in each. Both stars should therefore be examined as frequently and carefully as possible. β Lyræ is at minimum about midnight on Dec. 25.

There is an uncertainty about the ephemeris of R Andromedæ which renders observations of its brightness a matter of importance ; its spectrum, whilst resembling in several particulars that of the third type, possessing so many special characteristics, that it deserves the most careful attention directly the star has attained a sufficient magnitude.

THE RETURN OF THE LEONIDS IN 1885

Between November 5 and 13 inclusive we had densely overcast skies, so that no observations could be obtained here.

On November 14 weather improved, but it was not until the morning of the 15th that the clouds completely dispersed and enabled that uninterrupted view of the firmament which is so necessary to the successful recording of meteors. The three following nights were also brilliantly clear, though the severe frosts which occurred rendered open-air watching somewhat trying. I have summarised my results for the four mornings as follows :—

Date, 1885	Time of obs. a.m. h. h.	Actual duration of obs. h.	Meteors seen	Leonids	Radiant point ° °
Nov. 15	3½ to 6	2¼	24	4	149 +21
16	0¾ to 3	2	23	0	—
17	0¾ to 4¾	3½	42	6	150 +22
18	2¾ to 5¼	2¼	25	1	—
Nov. 15–18	0¾ to 6	10	114	11	149½ + 21½

Making certain allowances for the intervals occupied in registering the paths, &c., meteors fell at the rate of about 14 per hour for one observer. Of the total number seen 11 only belonged to the special shower of Leonids. The proportion of the latter to the meteors visible from all other streams was therefore as 1 to 10·4. Six of the Leonids appeared in Leo with much foreshortened tracks close to their radiant point, which admitted of very accurate determination. As usual, they left lines of phosphorescence which in several instances brightened most perceptibly about one or two seconds after the extinction of the nucleus. I have frequently noticed this after-glowing of the streaks which are so commonly generated by the swift meteors discharged from the radiants near the apex of the earth's way.

On the morning of the 15th the Leonid's furnished about two meteors per hour for one observer. On the 16th there was an apparent lull in the display, not one being observed. On the 17th there was a very distinct reappearance of the shower with the same relative intensity as on the 15th. On the 18th the shower had nearly become exhausted, for of 25 shooting-stars only one certainly could be assigned to the radiant in Leo.

It is extremely probable that the maximum took place, as it usually does, on the morning of the 14th, when unfortunately the sky was involved in clouds. But the observations now reported for the later nights of the display sufficiently prove there to have been a definite, though feeble, revival of the shower this year, and there can be no question that the Leonid meteor-orbit is continuous so far as our accumulating observations enable us to judge. Every November, as the earth crosses the node, meteors having the same radiant in the sickle of Leo are to be seen, and they exhibit all the characteristics typical of the Leonids during one of the major displays. There are doubtless some condensations in the orbit, giving rise to brighter showers in some years than in others, but a large number of further observations are required to determine the precise nature of these. There can be no doubt that there are certain occasions when fairly bright returns of these meteors pass wholly unobserved. Moonlight, cloudy weather, or the occurrence of a maximum in the daytime, may so much obliterate it as to induce entirely wrong impressions as to its comparative strength in successive years. We essentially require observers in widely different longitudes, and the continuity of annual records should be preserved as far as possible.

With regard to the display of the present year, the want of observations on November 12 and 13 will not allow us to form a safe judgment as to its character. Probably it has been below the average. As to the individual meteors recorded at this station, they were generally small, and, with one exception, need no comment. The brightest appeared at 5h. 3m. a.m. on November 15, and was estimated very nearly equal to Jupiter. Its path of 12° lay 5° south of β and γ Draconis, and it left a vivid streak there for about five seconds.

As to the numerous contemporary showers of this epoch, they are extremely interesting, and some of them were observed this year with unusual distinctness. In preceding years I have registered a considerable number of Taurids and Muscids at this epoch, but during my late observations not many were noticed. I was, however, watching a region of the heavens far removed from the radiant points of these showers—a fact which may in some measure explain the apparent paucity of their meteors. But on the 15th and 16th a few of the slow-moving Taurids were seen traversing long flights amongst the stars of Leo Minor and Ursa Major. At 2h. 20m. a.m. on November 16 one fell in a path of 17° slightly to the left, and very nearly parallel to the stars ζ and η of Ursa Major. It was brighter than Jupiter, and exhibited a small yellowish-white disk, varying in magnitude in a most curious manner. During its course the meteor appeared to halt and rekindle with increased impetus several times, and short trails of sparks were thrown off at the points of maximum brightness.

Below I give a summary of all the radiant points derived from my a.m. observations on November 15-18 last:—

No.	Radiant (° °)	No. of meteors	No.	Radiant (° °)	No. of meteors
1 ...	$149\frac{1}{2}+21\frac{1}{2}$ ...	11	7 ...	213+75 ...	8
2 ...	154 +41 ...	12	8 ...	157+74 ...	4
3 ...	166 +31 ...	10	9 ...	79+56 ...	6
4 ...	144 +50 ...	6	10 ...	73+42 ...	5
5 ...	125 +41 ...	6	11 ...	190+21 ...	3
6 ...	60 +28 ...	5	12 ...	100+41 ...	5

Nos. 2, 3, 4, and 5 are important. They severally furnish meteors of the swift streak-leaving class. No. 6 represents the centre of a few Taurids, and Nos. 7 and 8 are positions derived from slow meteors not very far from Polaris. Nos. 9 and 10 are a pair of sharply-defined radiants in Auriga, and No. 11 is an entirely new shower which I observed on the morning of the 17th and 18th. Only three of its meteors were recorded, but their paths intersect at a point, and I believe the position is reliable.

The radiant No. 2 at 154° + 41°, near μ Ursæ Majoris, is the best of all, and has often been seen in previous years. It is evidently the same as the "very active shower" described by me in NATURE, vol. xv. p. 158, as observed here from the point 155° + 36°, on November 20-28, 1876. It is also identical with the shower seen from 155° + 35° by Father Perry at Stonyhurst College Observatory on November 13-15, 1879 (*Monthly Notices*, January, 1880, p. 140). Not only in November, but in many other months, does this particular radiant point manifest itself. I have summarised the positions from September to December, though the shower is still sustained with equal definiteness until May:—

Radiant (° °)	Epoch	Observer or authority
155+41 ...	Sept. 8–October ...	D. From Zezioli's obs.
156+41 ...	September 15–16 ...	D. Obs. in 1877
153+42 ...	October 16	D. Obs. in 1877
152+38 ...	October 14	D. Obs. in 1879
160+40 ...	November 7, 1869 ...	Tupman (estimated)
149+38 ...	November 1–15, 1872	D. From Italian obs.
157+46 ...	November 11–15 ...	Denza
155+35 ...	November 13–15 ...	Perry. Obs. in 1879
154+41 ...	November 14–17 ...	D. Obs. in 1885
155+36 ...	November 25–27 ...	D. Obs. in 1876
154+39 ...	December 6–7	Backhouse
160+40 ...	December 8–9	Backhouse
152+43 ...	December 9–12... ...	D. From various foreign obs.
149+45 ...	December 9	Schiaparelli and Zezioli

The positions marked "D." are those resulting from my own observations or reductions. The two radiants at 160° + 40°, by Tupman and Backhouse, may possibly relate to another bordering shower, but the position is very close to the mean of all at

$$154°\cdot 4 + 40°\cdot 4.$$

This is a shower (or series of showers) which eminently stands in need of further investigation. The radiant appears to be stationary and continuous for a long period. The shower at 166° + 31°, 10° north of δ Leonis, which I detected this year, has escaped me before, though it was seen at Stonyhurst in 1879, November 13-15, at 166° + 22°. As to position No. 5 in my present list, I saw that well on November 12, 1877, at 125° + 40°. With reference to the radiant No. 4 at 144° + 50°. close to θ Ursæ, I have not recognised it in November until this year, but in October last I determined a good radiant at 143° + 49° from meteors seen in the morning sky.

These circum-Leonid streams reappear with more or less distinctness every year, and their radiant points are sharply defined. It would be well to thoroughly study the durations of several of them, now that their positions have been ascertained with a considerable degree of accuracy by several observers.

Bristol, November 19 WILLIAM F. DENNING

NOTES FROM THE OTAGO UNIVERSITY MUSEUM

VII.—*On some Models Illustrating Phyllotaxis*

PHYLLOTAXIS is a subject which presents special difficulties to the student when illustrated only by diagrams and by actual specimens of plants. With these aids alone it

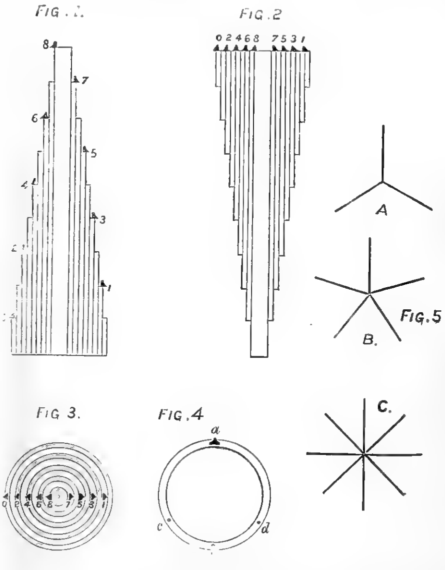

FIG. 1.—Vertical section of model, one-eighth actual size; 0-1, the leaf knobs.

FIG. 2.—The same, telescoped, the upper edges of all the cylinders being brought to one level.

FIG. 3.—The same, telescoped, and viewed from above.

FIG. 4.—One of the cylinders from above: *a*, the fixed leaf-knob; *b*, *c*, *d*, holes for the insertion of movable knobs

FIG. 5.—Wire stars to represent orthostichies: A, for divergence of one-third; B, for two-fifths; C, for three-eighths.

entails an expenditure of time, out of all proportion to the importance of the subject, to make clear in a lecture or demonstration the principles of leaf-arrangement and the mode of construction of the leaf-diagram.

I find the model about to be described of great assistance in explaining these matters. It consists of a "nest" of nine concentric cylinders, made of some hard wood (Fig. 1), the outermost 2 inches high, the others increasing in height by regular increments of 2 inches up to 18 inches. The cylinders are $\frac{1}{4}$ inch thick, except the innermost, which is a solid rod 1 inch in diameter: they are made so as to slide easily upon one another in any direction. The exposed portion of each cylinder, 2 inches in length, represents an internode, its upper edge a node. On the upper edge of each is fixed a small wooden knob (Fig. 1, 0–8) representing a leaf-insertion, and of such a size as to project slightly beyond the cylinder to which it is attached. By revolving the cylinders these knobs can be made to take up positions representing any divergence from $\frac{1}{2}$ to $\frac{3}{8}$; higher divergences would of course require a greater number of cylinders and consequently a larger and more unwieldy apparatus. In the figures the cylinders are shown adjusted to a divergence of $\frac{1}{2}$. The adjustment is facilitated by holding above the model a straight wire in the case of $\frac{1}{2}$ divergence, or a 3-, 5-, or 8-rayed wire star (Fig. 5, A, B, C) in the case of higher divergence. The genetic spiral is best shown by winding a piece of string round the model.

To explain the construction of the leaf-diagram, the whole apparatus is "telescoped" by simply lifting the lower cylinder: as the latter is raised each cylinder in turn is caught by the projecting portion of the leaf-knob of the next higher cylinder, until finally the upper edges—*i.e.* the nodes—of all nine are brought to one level, or in other words, the internodes are suppressed (Fig. 2). Then by observing the model end-on (Fig. 3), nine concentric circles are seen, each representing a node, and having a leaf-insertion in the appropriate position. To make this clearer, the upper edges of the cylinders are painted alternately light and dark, as in Fig. 3. The resemblance of the model in this position to the leaf-diagram is made still clearer by placing over it a straight wire or wire star (Fig. 5) to represent the orthostichies, and bring out the precise meaning of the angle of divergence.

For the illustration of whorled arrangements movable leaf-knobs are provided which can be inserted in small holes (Fig. 4, *b*, *c*, *d*) in the edges of the cylinders. By placing one of these movable knobs in *b* opposite to the fixed knob *a*, a 2-leafed whorl is produced; by placing knobs in *c* and *d*, a 3-leafed whorl. By revolving the cylinders successive whorls can be made either alternate or superposed.

I tried at first, some four years ago, a model having all the cylinders of the same height, each fitting rather tightly into the next lower one, which overlapped it about half an inch. But I found it impossible to get this arrangement to work satisfactorily, owing to the irregular contraction and expansion of the wood and the weight of the upper cylinders.

In addition to this model I find it very useful to have each divergence separately illustrated by a model having the form of a truncated cone 18 inches in height. The cone is painted white: black circles are drawn round it at regular intervals to represent nodes, on which black knobs are fixed for leaves: the orthostichies are painted yellow, and the genetic spiral red. In the case of the higher divergences these models are useful for showing the relations of the parastichies and the method of determining the divergence from them. Two secondary spirals running in opposite directions are made by passing two pieces of differently coloured string round the cone in opposite directions, each having a turn given to it round each leaf-knob in the parastichy it represents. T. JEFFERY PARKER

Dunedin, N.Z., October 9

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Dr. Vines has been appointed Honorary Secretary of the General Board of Studies for business connected with the lists of lectures issued by the Board.

Dr. A. S. Lea, Fellow of Gonville and Caius College, has been approved for and admitted to the degree of Doctor in Science.

A temporary iron dissecting-room for Human Anatomy is to be erected on space adjacent to the present Anatomical Schools. Over 145 men are engaged in dissection this term.

The honorary degree of Master of Arts has been conferred on Mr. Walter Heape, Demonstrator of Animal Morphology.

The Public Orator (Mr. J. E. Sandys), in presenting Mr. Heape for the degree, observed that Mr. Heape, *quantum inter lucrum et laudem intersit expertus*, had relinquished the brilliant prospects open to him in a mercantile career and had deliberately preferred to devote himself to scientific pursuits. In 1879 he was attracted to Cambridge by the high reputation of the late Mr. F. M. Balfour, and after working with him for three years in the newly-founded Morphological Laboratory, he had, during the three years that had elapsed since Prof. Balfour's lamented death, done good service as Demonstrator of Animal Morphology. In prosecuting his favourite studies he had considered nothing too small, nothing too great, for his attention; he had not only investigated the early development of the mole, but had also secured for the University Museum an exceedingly rare specimen of a wild male African elephant, which he had killed with his own hand in the South of Africa. "Magnum profecto est ultimâ ex Africâ spoliis opimis onustum redîsse; laudem vero majorem eidem distinat virtus—

> "Diadema tutum
> Deferens uni, propriamque laurum,
> Quisquis ingentes oculo irretorto
> Spectat acervos."

An examination for two minor Scholarships will be held at Downing College on June 1, 2, and 3, 1886. The examination in Natural Sciences will include most of the subjects of the Natural Sciences Tripos except Geology and Mineralogy, but no one will be examined in more than three subjects, and great weight will be attached to proficiency in one subject.

The Clothworkers' Exhibition of 52*l.* 10*s.* a year for Physical Science has been awarded to Mr. G. A. Shaw; the Exhibition of 30*l.* to Mr. J. Morgan.

The Antiquarian Museum is growing in value by the donations, both general and local, which it has received. The Curator, Baron von Hügel, has accomplished much in the arrangement of the objects, and has himself deposited valuable collections on loan.

SCIENTIFIC SERIALS

THE *Botanical Gazette* (Indianapolis) for September and October is chiefly occupied by a report of the papers read in the Botanical Section of the American Association for the Advancement of Science at its Ann Arbor meeting. These furnish satisfactory evidence of the good work doing in this branch of science on the American continent, and will not suffer from comparison with a similar record at any of the recent meetings of our own Association. The following are the titles of the papers read:—J. C. Arthur, proof that Bacteria are the direct cause of the disease in trees known as pear-blight.—C. R. Barnes, the process of fertilisation in *Campanula americana.*—C. E. Bessey, the question of bi-sexuality in the Zygnemaceæ.—C. E. Bessey, further observations on the adventitious inflorescence of *Cuscuta glomerata.*—T. J. Burrill, the mechanical injury to trees by cold.—D. H. Campbell, the development of the prothallia of ferns.—J. M. Coulter, on the appearance of the relation of ovary and perianth in the development of dicotyledons.—W. G. Farlow, notes on some injurious fungi of California.—E. L. Sturtevant, an observation on the hybridisation and cross-fertilisation of plants.—E. L. Sturtevant, germination studies.—As far as these papers are reported here, we may note Mr. Arthur's, Mr. Barnes's, Mr. Campbell's, and Mr. Coulter's as giving especially good evidence of a capacity for original work. Another interesting feature of this number is the report of the proceedings of the "Botanical Club," which held daily meetings during the session of the Association, with an attendance in all of no less than eighty-five members.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 19.—"On Variations in the Amount and Distribution of Fat in the Liver-Cells of the Frog." By J. N. Langley, M.A., F.R.S., Lecturer on Histology in the University of Cambridge.

The fat in the liver-cells is at its maximum amount in February and March. In April it rapidly decreases; from May until December it is present in comparatively small though varying amount.

Generally speaking, the fat globules form an inner zone in frogs which have hungered more than a week. In January, February, and March, however, the fat-globules are commonly more numerous in the outer part of the cells, often forming a distinct outer zone.

In December, when the fat in the liver is increasing in amount, cold increases the amount of fat stored up, and warmth decreases it.

The increase of fat, consequent on a decrease of temperature, occurs chiefly in the outer part of the cells.

The decrease of fat, consequent on increase of temperature, occurs chiefly or wholly at the outer part of the cells; as a rule, the number of globules in the inner part of the cells is increased.

Variations of temperature have much greater effect on the amount of fat in the liver in winter than in summer.

The ratio of fat formed to fat metabolised, depends in part upon certain unknown conditions of the body, independent of temperature or of food.

When frogs are fed, *e.g.* with worms, the fat in the liver at first decreases; after some hours it begins to increase, and becomes greater than at the beginning of digestion; towards the end of digestion it decreases again in amount, so that in one or two days the amount is normal. Whilst the fat is decreasing in amount, the globules usually decrease in size; whilst the fat is increasing in amount, the globules usually increase in size, and are found in the outer region of the cells. Later, as the fat returns to normal, the globules form more and more an inner zone.

Probably the metabolism as well as the formation of fat is more rapid in the outer than in the inner cell-region; and probably also there is in certain circumstances a transference of fat-globules from the outer to the inner part of the cells.

Each separate fat-globule appears to be slowly metabolised in the same way that mesostate granules in secretory glands are metabolised.

From June to August, peptone or dextrin, when injected into the dorsal lymph-sac of a frog, produces changes like those produced by feeding.

Mathematical Society, December 10.—J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. A. E. Haynes, Hillsdale College, Michigan, was elected a Member.—The following communications were made:—On the numerical solution of cubic equations, by G. Heppel.—On a theorem in kinematics, by J. Y. Walker, F.R.S.—Note on the induction of electric currents in an infinite plane current sheet which is rotating in a field of magnetic force, by A. B. Basset.

Chemical Society, November 19.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—Aluminium alcohols; part 3, aluminium ortho-cresylate and its products of decomposition by heat, by J. H. Gladstone, F.R.S., and Alfred Tribe.—Notes on the constitution of hydrated and double salts, by Spencer U. Pickering.—Some new vanadium compounds, by J. T. Brierly.—On the action of PCl_5 upon ethylic diethylacetoacetate, by J. W. James.—On the vapour-pressures of mercury, by W. Ramsay, Ph.D., and Sydney Young, D.Sc. After criticising Regnault's determinations of the vapour-pressures of mercury, the authors show that his results do not agree with the following generalisation, which has been proved to be true in twenty-two instances. A relation exists between the absolute temperatures of all bodies, whether solid or liquid, whether stable or dissociable, which may be expressed in the case of any two bodies by the equation

$$R' = R + c(t' - t).$$

where R is the ratio of the absolute temperatures of the two bodies corresponding to any vapour-pressure, the same for both; R' is the ratio at any other pressure, again the same for both; c is a constant which may equal 0, or a small plus or minus number; and t' and t are the temperatures, absolute or Centigrade, of one of the bodies corresponding to the two vapour-pressures. When $c = 0$, $R' = R$, or the ratio of the absolute temperatures is a constant at all pressures; and when $c > 0$ or $c < 0$, its values may readily be determined either by calculation, or graphically by representing the absolute temperatures of one of the two bodies as ordinates, and the ratios of the absolute temperatures at pressures corresponding to the absolute temperatures of that body as abscissæ. It is found in all cases that points representing the relation of the ratio of the absolute temperatures of the two bodies to the absolute temperatures of one of them lie in a straight line. From this it follows that if the vapour-pressures of any one substance are known throughout, it is sufficient to determine accurately the vapour-pressures of any other substance at any two temperatures, sufficiently far apart, in order to be able to construct its whole vapour-pressure curve. The vapour-pressures of mercury have accordingly been measured with the greatest care at the temperatures $222°\cdot15$ C., $270°\cdot3$, $280°\cdot2$, $447°$, and $448°$. On comparing the ratios of the absolute temperatures of mercury and water, at pressures corresponding to those temperatures, they are found to agree with the equation $R' = R + c(t - t')$, where $c = 0\cdot0004788$, if the temperatures of mercury be chosen as ordinates. It is therefore possible to construct the complete vapour-pressure curve of mercury; the paper contains tabular statements of the values.

Linnean Society, December 3.—Sir J. Lubbock, Bart., President, in the chair.—Sir H. E. Maxwell, Bart., Lieut.-Col. L. Blathwayt, and Messrs. R. A. Bastow, S. J. Capper, C. Ford, G. B. Howes, J. H. Gurney, jun., W. H. Jones, W. F. A. Lambert, C. T. Musson, W. D. G. Osborne, D. Petrie, and G. Thom were elected Fellows.—The President announced from the chair, and there were read letters from (1) the Elizabeth Thompson Science Fund, U.S.A.; (2) Prix de Candolle; (3) Medals and money prizes of Roy. Soc. N.S. Wales.—The Secretary exhibited for M. Buysman a preparation of the floral parts of *Aconitum Napellus*, L.—Mr. V. I. Chamberlain exhibited and made remarks on a specimen of trap-door spider and nest from California.—D. C. Cogswell showed oil-paintings of *Eugenia jambos* and *Casparea porrecta* from Bermuda.—The Rev. G. Henslow read a contribution to the study of the relative effects of different parts of the solar spectrum on the transpiration of plants. His conclusions are: that his experiments prove that Wiesner's results are correct, and that transpiration *per se* (theoretically distinct from the purely physical process of evaporation, which takes place from all moist surfaces and bodies, dead or alive) is especially, if not solely, referable to those particular bands of light which are absorbed by chlorophyll, and that such light, being arrested, is converted into heat, which then raises the temperature within the tissues and causes the loss of water. The only additional results advanced tentatively are, that yellow light has a *retarding influence* upon transpiration, and that "life" has a retarding influence upon evaporation as distinct from transpiration.—Prof. T. S. Cobbold's notes on parasites collected by the late Charles Darwin was next read. This contains a letter from Mr. Darwin when transmitting the author the specimens in 1869, followed by Dr. Cobbold's own memoranda concerning eight of them, only one, however, *Distoma incerta*, proving new.—A paper was read, on *Castilloa elastica*, Cerv., and some allied plants, by Sir J. D. Hooker. The author states that under the name *Castilloa elastica* probably more than one species exists. The true plant first described by Cervantes has flowered and fruited in Ceylon; it is now fully described and figured, with remarks on allied plants also yielding Panama india-rubber. Seeds collected by Mr. Cross in 1875 failed to germinate, but cuttings were also introduced, and from them plants were distributed to various colonies. Some difficulty is found in propagating by cuttings, as the side branches, which are deciduous, will not strike root, but seedlings have now been raised at Peradenyia, and the culture is therefore assured. An account of the introduction of the plant is appended.—A paper was read by Mr. P. H. Carpenter, on the variations in the form of the cirri in certain Comatulæ. The shape and number of the cirrus-joints of *Antedon phalangium* vary so greatly, both in the same individual and in individuals from different localities, that, if the two extreme forms were met with in an isolated condition, they would assuredly be referred to different species of *Antedon*. The cirri of this species are classed by the author under four types:—(A) long-jointed, (B) intermediate, (C) square-jointed, (D) short-jointed. A is the typical form which occurs in the Mediterranean variety, but is also found in the Atlantic specimens, together with B, and also, but more rarely, C; while D is confined to individuals from the Minch and the Ross-shire coast, occurring together with C, which is rare in examples from the Atlantic, except in those dredged by the *Dacia* on the Seine bank.—The Secretary summarised a paper, by Mr. Joseph Baly, on the Colombian species of the genus Diabrotica, and in which the author divides the genus into two sections, dependent on the lengths of the second and third joints of the antennæ.

Zoological Society, December 1.—Prof. W. H. Flower, V.P.R.S., President, in the chair.—Mr. F. Day exhibited and made remarks on a very curious fish, supposed to be a hybrid between the Dab (*Pleuronectes limanda*) and the Flounder (*P. flesus*).—Mr. Sclater laid on the table specimens of some rare birds sent for exhibition by Mr. Whitely, of Woolwich, and called special attention to a Hornbill which seemed to prove that *Buceros casuarinus*, described by Mr. G. R. Gray in 1871 from the head only, was merely the young stage of *Bycanistes cylindricus*.—Mr. E. Lort Phillips exhibited a fine series of heads of antelopes obtained during his recent expedition to Somali-land in company with Messrs. James, and read notes on their habits and localities.—Mr. W. T. Blanford exhibited, on behalf of Capt. C. S. Cumberland, the head of a wild sheep from Ladak, supposed to be a hybrid between *Ovis hodgsoni* and *Ovis vignei*.—Mr. John Bland Sutton read a paper on the origin of the urinary bladder, in which he endeavoured to show that the atrophy of the gills in all forms of the vertebrates above the amphibians might possibly be explained by the assumption of embryonic respiration by the allantois.—A communication was read from Lieut.-Col. Swinhoe, containing the fourth part of his memoir on the Lepidoptera of Bombay and the Deccan. The present paper concluded his description of the Heterocera; and also contained descriptions of the Tortricidæ and Tineina, which had been worked out by Lord Walsingham.—A communication was read from Dr. R. W. Shufeldt, containing a memoir on the comparative osteology of the Trochilidæ, Caprimulgidæ, and Cypselidæ. Dr. Shufeldt came to the conclusion that the Trochilidæ should form an order by themselves, and were not nearly related to the Cypselidæ, which were only much modified Passeres.—Mr. F. E. Beddard read the second of his series of notes on the Isopoda collected during the voyage of H.M.S. *Challenger*. In the present paper the author treated of specimens referable to the family Munnopsidæ.—A communication was read from Mr. Martin Jacoby, containing descriptions of some new species and a new genus of Phytophagous Coleoptera.

Physical Society, November 28.—Prof. F. Guthrie, President, in the chair.—Mr. T. H. Blakesley was elected a Member of the Society.—The following communications were read:—On the calibration of galvanometers by a constant current, by Mr. T. Mather. A current is passed through the coils of a galvanometer, which may be of any form; the galvanometer is turned in a horizontal plane through any angle, which need not be recorded, and the deflection θ of the needle noted. The current is then broken, and the needle swings back, taking up its position in the magnetic meridian; the angle through which it turns to do this is also noted δ. This is repeated with the galvanometer in various positions and with the same current, and a curve is drawn showing the relation between the values of $\frac{\sin\theta}{\sin\delta}$ and corresponding values of θ. When the instrument is now used in its normal position it is readily seen that a current producing a deflection θ of the needle is proportional to the value of $\frac{\sin\theta}{\sin\delta}$ corresponding to θ, obtained in the calibration experiment which may be read off at once from the curve.—On a machine for the solution of cubic equations, by Mr. H. H. Cunyngham. This machine the author believes to be the only one hitherto constructed that gives the imaginary as well as the real roots of a cubic equation. A cubical parabola is drawn upon paper, the ordinates being the cube roots of the corresponding abscissæ. To find the roots of a cubic, first reduce it by Cardan's rule to the form $x^3 - Ax - B = 0$. Then measure off along Ox, a distance equal to B, and from this point, T, draw a line making an angle equal to $\cot^{-1}A$ with Ox. The ordinates of the points where this line cuts the curve are the roots of the equation. To find the imaginary roots when they exist, first find the real root as before; from this point draw a tangent to the branch of the curve the other side of Oy, then if this line cut the axis of x at a point Q, and α be the real root, the two imaginary roots are

$$\frac{\alpha}{2} \pm i\sqrt{\frac{QT}{\alpha}}.$$

Instead of actually going through the construction as above, the operation is preferably performed by applying a protractor with a tangent scale to the curve with its centre at T, setting it, and leading off the point of the curve cut by its edge.—On a machine for the solution of equations, by Mr. C. V. Boys. After mentioning Mr. Hinton's apparatus, lately shown to the Society, and briefly describing Mr. Kempe's equation-machine, Mr. Boys explained a machine he had constructed, consisting of a system of beams, each provided with a pair of pans, and working upon a fulcrum at the middle. The pans of the first beam are marked $+a$ and $-a$, those of the second $-b$ and $+b$, the next $+c$ and $-c$, and so on. Into these, weights equal in value to the coefficients a, b, c, &c., of an equation $a + bx + cx^2 + \ldots = 0$ are to be placed. A sliding joint is arranged to connect a point opposite the positive pan of each beam, with a rib at the back of the next lower one. Alternate beams are placed opposite one another, and each set can be slid past the other, the peculiar connecting-joints being able to slide past the fulcra and the pans on each beam. To solve an equation, the coefficient weights are placed in their pans, and the two sets of beams are made to slide past one another. At certain positions the beams change the direction of inclination. These positions of balance are noted on a scale, the readings of which are roots of the equation. When there are not more than two impossible roots, the machine will find them; for this purpose the real roots are first found and divided out, the resulting quadratic being placed on the machine. Instead of a change of inclination of the beam, a maximum or minimum of pressure is observed by a spring balance. The reading of the scale is then the real part of the root, and the square root of the pressure the impossible part.—Mr. A. Hilger exhibited and described a new driving clockwork of isochronous motion regulated by a fan-governor, and a new direct-vision spectroscope.

Geological Society, November 8.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Henry M. Ami and R. Mountford Deeley were elected as Fellows of the Society.—The following communications were read:—Results of recent researches in some bone-caves in North Wales (Fynnon Beuno and Cae Gwyn), by Henry Hicks, F.R.S., with notes on the animal remains by W. Davies, F.G.S., of the British Museum (Nat. History). This paper contained the results of researches carried on in these caverns in the summers of 1883, 1884, and 1885 by Mr. E. Bouverie Luxmoore, of St. Asaph, and the author. The enormous collection of bones belonging to the now extinct animals of Pleistocene age obtained had been submitted for examination to Mr. W. Davies, and afterwards distributed to various museums. Several well-worked flint implements were also discovered in association with the bones. The following are the conclusions arrived at by the author, from the facts obtained during the explorations:—That abundant evidence has been furnished to show that the caverns had been occupied by hyænas, and possibly by other beasts of prey, as dens, into which portions of carcasses of various animals had been conveyed in Pleistocene times. The very great abundance of some animals, such as the rhinoceros, horse, and reindeer, and the frequent presence of bones belonging to young animals, proved that the plain of the Vale of Clwyd, with that extending northward under the Irish Sea, must have formed a favourite feeding-ground even at that time. The flint implements and worked bones showed also that man was contemporary with these animals. The facts perhaps, however, of greatest importance, made out during these researches, are those which bear on some questions of physical geology in regard to this area, which hitherto have been shrouded more or less in doubt. The views on the physical conditions in Pleistocene times of the areas in North Wales in which these and the other bone-caverns occur, so ably put forward by Sir A. Ramsay, appeared to the author to be strongly supported by the results obtained in these explorations. The ravine in which the caverns occur must have been scooped out previous to the deposition in it of the glacial sands and boulder-clays. This sand and clay, there seems good evidence to show, must have filled up the ravine to a height above the entrances to the caverns, and such sands and clays are now found at some points to completely fill up the caverns. How, then, did these sands and clays get into the caverns? Were they forced in through the entrances by marine action or by a glacier filling the valley? Or were they conveyed in subsequent to the deposition of the boulder-clay in the valley and surrounding area? The position of the caverns in an escarpment of limestone, at the end of a ridge of these rocks, with a sharp fall on either side, prohibits the idea that the material could have been washed in from the higher ground, as has been suggested by some in the case of other caverns, if it had anything like its present configuration. Moreover, there is scarcely any deposit now visible upon the limestone ridge, and there is no certainty that there ever was deposited there any great thickness of such a clay as that now found in the caverns. The general position also of the bones in some of the tunnels seems to indicate clearly that the force which broke up the stalagmite floor, in some places 10 to 12 inches thick, and stalactites 6 to 8 inches across, which thrust many of the large and heavy bones into fissures high up in the caverns and placed them at all angles in the deposit, must have acted from the entrance inwards, and the only force which seems to meet these conditions is marine action. The following seem to the author to be the changes indicated by the deposits. The lowest in the caverns, consisting almost entirely of local materials, must have been introduced by a river which flowed in the valley at a very much higher level than does the little stream at present. Gradually, as the valley was being excavated, and the caverns were above the reach of floods, hyænas and other beasts of prey occupied them, and conveyed the remains of other animals into them. Man also must have been present at some part of this period. Gradually the land became depressed, the animals disappeared, stalagmite was formed, and the sea at last entered the caverns, filling them up with sands and pebbles, and burying also the remains not washed out. Floating ice deposited in this sea the fragments of rocks derived from northern sources, and these became mixed with local rocks and clays brought down from surrounding areas. The greater part of the boulder-clay in the Vale of Clwyd was probably deposited as the land was being raised out of this Mid-Glacial sea. During the process of elevation the caverns became again disturbed by marine action and the upper fine reddish loam and the laminated clays were deposited. It seemed to the author impossible to avoid the conclusion that these caverns must have been submerged, and afterwards elevated to their present height of about 400 feet above the level of the sea, since they were occupied by Palæolithic man and the Pleistocene animals.—On the occurrence of the Crocodilian genus *Tomistoma* in the Miocene of the Maltese Islands, by R. Lydekker, F.G.S.—Description of the cranium of a new species of *Erinaceus* from the Upper Miocene of Œningen, by R. Lydekker, F.G.S.

Anthropological Institute, Nov. 24.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of W. Seton Karr, E. Lawrence, Dr. R. Munro, and Dr. W. Summerhays, was announced.—Mr. C. H. Read exhibited a number of ethnological objects from Terra del Fuego.—The President exhibited on behalf of Dr. J. E. Billings, of the United States Army, a collection of composite photographs of skulls. There were in all twenty photographs, forming four series, referring respectively to Sandwich Islanders, Ancient Californians, Arapahoe Indians, and Witchitaw Indians; each composite was the mean of six adult male skulls.—Dr. Edward B. Tylor exhibited some Australian Tunduns or bull-roarers, and explained the manner in which they were used.—Mr. J. Theodore Bent read a paper on insular Greek customs, in which he described many ceremonies now used by the Christian inhabitants of the islands of the Ægean Sea that were obviously derived from, or survivals of, ancient Pagan customs. Mrs. Bent exhibited a collection of Greek dresses, drapery, and other objects from the islands referred to in the paper.—Mr. J. W. Crombie read a paper on the game of hop scotch, in which he traced the origin of the game to a period anterior to the introduction of Christianity, and showed that in early Christian times children had some rough idea of representing in this game the progress of the soul through the future world, and that the division of the figure into seven courts was on account of the belief in seven heavens.—Dr. E. B. Tylor gave a *résumé* of a paper by Mr. A. W. Howitt, on the migrations of the Kurnai ancestors (Gippsland).

Royal Microscopical Society, November 11.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—The President referred in feeling terms to the death of Dr. W. B. Carpenter, C.B., a Fellow, and formerly President, of the Society, and a resolution of condolence with his family was passed. Prof. Stewart was appointed to represent the Society at the funeral.—Mr. Beck exhibited a portable form of his "Star" microscope, and Mr. Crisp exhibited a microscope with focussing adjustment by means of a piece of catgut, which, it was claimed, gave a very simple and easy motion.—Mr. J. Mayall, jun., exhibited the Helot-Trouvé electric photophore, which had been recommended as an excellent illuminant for microscopical purposes.—Mr. Groves exhibited a Barrett microtome, a very large form, intended for cutting sections of exceptional size.—Mr. Dowdeswell exhibited a cholera bacillus showing a flagellum at either end, one straight and the other coiled.—Mr. Nelson exhibited a very fine image of *Triceratium septangulatum*, showing markings in the areolation with a $\frac{2}{3}$-inch objective, and the low aperture of 0·29.—Mr. Badcock described an unknown fresh-water organism, closely resembling a Polycystin. The President suggested that it might possibly be one of the various forms of *Actinophrys*.—A paper was read by Mr. W. B. Turner, describing some new and rare Desmids; also one, by Dr. Giltay of Holland, on the proper mode of describing the amplifying power of a lens or objective.—Mr. Crisp read a paper on the limits of resolution in the microscope, in which he showed that whilst the limit with white light might be taken at 146,543 lines to the inch, the use of monochromatic light gave an increase to 158,845, and with photography to 193,037.—A paper was read by Dr. Lavis on preparing sections of pumice and other vesicular rocks.—It was announced that Mr. Mayall, jun., was about to give a course of five lectures on the microscope at the Society of Arts, illustrated by microscopes from the Society, and from Mr. Crisp's extensive collection.

Mineralogical Society, December 8.—L. Fletcher, M.A., President, in the chair.—The following papers were read:—On a glaucophane eclogite from the Val d'Aoste, by the Rev. Prof. Bonney, F.R.S.—Note on orthoclase from Kilima-njaro, by H. A. Miers, M.A.—Preliminary notice of penetration twins of arragonite from New Mexico, by R. H. Solly, F.G.S.—On some specimens of idocrase and garnet from the neighbourhood of Tzermatt, by Prof. W. J. Lewis.—Dr. Burghardt exhibited some pseudomorphs of native copper after arragonite, from South America.—Mr. Miers also exhibited some peculiar twins of calcite from Eyam, Derbyshire.

Entomological Society, December 2.—Mr. J. W. Dunning, Vice-President, in the chair.—Two new Fellows were elected.—Mr. F. Enock described experiments in mounting *Mymaridæ*, and exhibited photographs of the insects.—Mr. A. Eland Shaw exhibited an undetermined species of *Conicephalus*, which had been taken in a hothouse at Birmingham; it was believed to be an Australian or South American species.—Mr. G. T. Porritt exhibited two species of a melanic variety of *Ayrotis obelisca* from Sligo.—Mr. Dunning read a note on the election of honorary foreign members.

Victoria Institute, December 7.—A paper on the unreasonableness of agnosticism was read. The author treated the subject in such a manner as to make his essay specially valuable at this time.—Mr. E. Charlesworth read a paper on the skull of the gorilla, of which he exhibited a specimen considered the most perfect that had as yet reached England.

CAMBRIDGE

Philosophical Society, November 23.—Prof. Foster, President, in the chair.—The following communications were made:—On a new method of producing the fringes of interference, by L. R. Wilberforce, B.A. The author stated that in the course of an inquiry into the suitability of various forms of interference-fringes for certain investigations on the velocity of light upon which he had been engaged, he had been led to adopt the mode of production which was the subject of his paper. He briefly described the method, indicated the elements of its theory, and, by a comparison of his results with those of former experimenters, showed the great increase of accuracy attainable by means of it.—On the dielectric strength of mixtures of gases, by Dr. C. Olearski. The author described a series of experiments from which it followed that the dielectric strength of a mechanical mixture of two gases is intermediate between the strengths of its constituents.—On the mutual action of oscillatory twists in a vibrating medium, by A. H. Leahy, M.A.—On the transpiration stream in cut branches, by F. Darwin, M.A., and R. W. Phillips, B.A. The paper consists chiefly of an experimental criticism of Dufour's experiments on transpiration. The authors show that (contrary to Dufour's contention) there is an essential similarity between the natural current of water in a transpiring branch, and the current induced by pressure in a similar specimen; this similarity being understood to hold good under the conditions of Dufour's experiments, namely, when certain incisions are made, or when the branch is compressed in certain ways.

PARIS

Academy of Sciences, December 7.—M. Jurien de la Gravière, Vice-President, in the chair.—Determination of the differences of longitude between Paris, Milan, and Nice, by MM. F. Perrier and L. Bassot. The values obtained for the differences of longitude between the observatories of these places is found to be:—

Milan–Paris ...	+27m. 25·315s.		
Paris–Nice ...	−19m. 51·513s.	27m. 25·325s.	Δ=0·01s.
Nice–Milan ...	− 7m. 33·812s.		

—Movement of the molecules of the so-called "solitary wave" propagated on the surface of a stagnant canal, and which after some agitation acquires a constant and uniform motion, by M. de Saint-Venant.—Experimental researches undertaken to determine the influence exercised by lesions of the spinal marrow on the form of the convulsions assumed by artificial epilepsy of cerebral origin, by M. Vulpian.—On the theory of algebraic forms in connection with M. Halphen's differential invariants, by M. Sylvester.—Note on the fresh experiments carried out in 1885 with the navigable balloon *La France*, by M. Ch. Renard. The results of three ascents during the months of August and September gave a mean velocity of about 6·7 metres per second, with 55 to 57 revolutions of the screw per minute. On the two last occasions the balloon was brought back to the point of departure, Chalais, near Meudon.—On the propagation of motion in an undefined fluid (1st part), by M. Hugoniot.—Discovery of a new comet in the constellation Andromeda at the Paris Observatory on December 1, by M. Fabry.—Observations made at the Observatories of Paris, Bordeaux, Lyons, and Algiers, presented by M. Mouchez.—On the employment of spherical convex glasses (boules-panorama) as solar signals, by M. Hatt.—Note on certain hyper-Fuchsian functions, by M. E. Picard.—On Lagrange's form of interpolation, by M. Bendisson.—Note on the trigonometric series, by M. H. Poincaré.—On the solutions common to several partially-derived linear equations, by M. R. Liouville.—On the holomorphous conditions of the integrals of the iterative equation, and on some other functional equations, by M. G. Kœnigs.—Remarks relative to a preceding communication on M. Kœnig's theorem, by M. Ph. Gilbert.—On the part played by the rotation of the earth in determining the deviation of running waters on the surface of the globe, by M. Fontes. The author considers it now demonstrated that terrestrial rotation has a perceptible influence on the tendency shown by rivers to corrode one side or the other of their banks.—Note on the spectrum of absorption of oxygen, by M. N. Egoroff. The results of the author's spectroscopic researches, combined with those of M. Thollon, completely explain the origin of the telluric bands in the section A—*b* of the solar spectrum; 126 bands, distributed in equal proportion and identically in the groups A, B, and α, depend exclusively on oxygen, while the others belong to the vapour of water.—On the characteristic equation of carbonic acid, by M. E. Sarrau.—On the preparation of hypophosphoric acid, by M. A. Joly.—Note on some properties of zinc, by M. L. L'Hôte. Pure zinc, alloyed with a very small quantity of arsenic or antimony, conducts itself in water like zinc alloyed with iron. Hence all the zincs of commerce decompose water at the boiling-point.—Heat of combustion of some ethers of organic acids: ethylic ether of lactic acid, citrate of ethyle, normal ethylbutyric ether, ethylisobutyric ether, by M. Louguinine.—On the pyrogenous decomposition of the polyatomic acids of the fatty series, by M. Hauriot.—On the normal and primary monochlorurretted butyric compounds, by M. Louis Henry.—Action of chlorine on anhydrous chloral, by M. Henri Gautier.—Analysis of the deposits formed by the mineral waters of Chabetout, Puy-de-Dôme, by M. Fr. Thabuis. The chief constituents of the deposits from these ferruginous waters are sesquioxide of iron, nearly 50 per cent.; organic matter, 9·4; lime, 2·2; gelatinous silica, 11·1; carbonic acid, 1·8.—Optical examination of some little-known minerals: kirwanite, a silicate of the protoxide of iron, lime, and alumina, with about 4 per cent. of water; hullite, consisting mainly of amorphous matter, and found in the Irish basaltic rocks; harringtonite, a zeolithe of lime and soda; bowlingite, a hydrosilicate of alumina, iron, and magnesia; botryolite, identical with datholite, by M. A. Lacroix.—On experimental denutrition, by M. Ch. E. Quinquand. This process, which consists in *starving* an organ, or part of an organ, supplies a new and useful method of investigation, enabling physiologists to advance the study of elementary nutrition and of the fundamental action of medicines.—On the effects produced by the ingestion and intra-venous injection of some colouring substances derived from coal, and much used in colouring drinks and aliments, by MM. P. Cazeneuve and R. Lépine. One of these (binitronaphthol, or Manchester yellow), is shown to be distinctly injurious; the other two derived from it quite harmless.—On the anatomy, digestive, and nervous systems of the genus Discina, by M. L. Joubin.—Account of a young megaptera recently stranded in the maritime district of La Seyne (Mediterranean), where this species of whale is extremely rare, by M. G. Pouchet.—On the respiration of plants, continued, by MM. G. Bonnier and L. Mangin.—On the desiccation of plants immersed in aqueous solutions, by M. Albert Levallois.—On the processes of fructification of the various genera of sigillaria, by M. B. Renault.—On the underlying rocks of the Tertiary formations in the neighbourhood of Issoire, Auvergne, by MM. Michel Lévy and Munier-Chalmas.—Geological observations on the kingdom of Shoa and Galla country, south of Abyssinia, by M. Aubry.—Note on the discovery of phosphates of lime made in the spring of the present year in the lowest Tertiary strata in the south of Tunis, by M. Philippe Thomas.—On the Jebel Zaghwan range, Tunis, and on the great fault in this orographic system running north-east and south-west, and indicating the line of upheaval of the lower chalk formations now in contact with the Upper Eocene rocks, by M. G. Rolland.—Note on the discovery of a human station dating from the Stone Age in the woods of Clemert, by M. Emile Rivière.—On the advantages to be derived from a thorough knowledge of the displacements of the Gulf Stream in weather forecastings, by M. de Tastes.—Various communications on the shooting stars of November 27, from M. Stephan, of the Marseilles Observatory; M. Hirn, of Colmar; M. Colladon, of Geneva; M. Perrotin, of Nice; M. Quenin, of Pelonne (Drôme); MM. Hildebrandsson and Charlier, of Upsala; M. Phipson, of London; and others, with remarks by M. Faye.

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THURSDAY, DECEMBER 24, 1885

THE LOAD-LINES OF SHIPS

THE regulation of the depth of loading of ships is a matter that has received the attention of scientific men and practical seamen during many years. It has been hotly discussed in various quarters, and numerous disputes have arisen over the attempts of the Board of Trade to carry their views respecting it into practice. A long series of debates and disputes culminated in the appointment of a Committee by Mr. Chamberlain, the late President of the Board of Trade, to report upon the question.

That Committee, now well known as the late Load-line Committee, had Sir E. J. Reed, K.C.B., M.P., for its Chairman, and reported to the President of the Board of Trade in August last. The Report was unanimous; and was conclusive as to the practicability of framing general rules concerning freeboard which will prevent dangerous overloading without unduly interfering with trade. The Committee's rules have been accepted by the Board of Trade and Lloyd's Register Society; and at the same time they have received the general approval of ship-owners.

Like many answers that are given to questions, the Committee's Report states the opinions that were arrived at, but does not give the reasons for them. This natural omission has been supplied by a paper read before the Society of Arts on the 11th inst., by Prof. Elgar, of Glasgow University, who was a member of the Committee. Prof. Elgar said:—

"It is necessary to understand the causes of the differences between the various types of vessels. It must be obvious that no simple rule of a given number of inches per foot of depth of hold, can now be applied with equal fairness to all vessels alike. Each requires to be judged of separately, and to have its special characteristics adequately appreciated. The problem of framing a general scheme for regulating the freeboards of the principal types of ships involves, firstly, the consideration of how freeboards should vary in vessels belonging to any given type, according to size, proportions, and form; and, secondly, the consideration of how the freeboards of vessels of similar sizes, proportions, and forms, but of different types, should be regulated relatively to each other."

He went on to show how the elements of size and relative proportions are dealt with in the Committee's tables, and also how form is taken into consideration by means of approximate coefficients of fineness.

The effects of differences in sheer and round of beam are separately investigated, and also the influence of deck-erections—such as forecastles, poops, midship houses, and others—upon seaworthiness. The whole question of allowances for deck-erections of various kinds is one which cannot be brought within the scope of exact different treatment; and it is a point upon which the Committee appear to have been guided more by the opinions of seamen and by the recorded experience of successful ship-owners than by any other considerations.

Among the chief scientific questions connected with the safe loading of ships are those of structural strength and stability. Prof. Elgar describes as follows the manner in which these have been treated by the Load-line Committee:—

"Flush-decked steamers of the 100 A class in Lloyd's Register, which are of full strength to the upper deck, are, it is known, amply strong enough to bear loading to the freeboards given in the tables. Spar and awning deck-vessels, which are of less strength, may become unseaworthy through excessive straining action at sea if loaded to the same depths as the vessels above-named. And there are instances of vessels of those types having been severely strained at sea, and of some which have probably foundered in consequence, when loaded unduly deep. The principle which the Committee has adopted in dealing with these and other vessels that are inferior in strength to those of the 100 A class of full scantling ships in Lloyd's Register, is to fix approximately the limits at which the stress upon the material of the hull shall not exceed that of the stronger class of the same proportions, form, and moulded depth, when loaded to the freeboard required by the tables. In our present state of knowledge of how to calculate exactly the relative stresses upon the materials of ship's hulls, it is impossible to rely upon absolute accuracy of comparison, but the principle is a sound one. It can be applied with a fair degree of accuracy in many cases, and it is only to be expected that the present deficiencies in this branch of science will be made good in time. In thus adopting Lloyd's 100 A class as a standard of strength, the Committee must not be supposed to indorse Lloyd's Rules in any sense. They are merely taken by the Committee as being the best, or, indeed, the only recognised standard we now have.

"The question of stability is one that has often been raised in connection with the regulation of freeboards. Stability is, however, so intimately associated with stowage that it is only possible to deal with it by defining how ships of various proportions and types are to be stowed. The Load-line Committee did not feel called upon to deal with an independent problem of such magnitude and such great complexity as this. Stability need not ordinarily enter into the determination of the load-line, except for the purpose of insuring to ships of great proportionate depth the necessary stability at sea when employed in the carriage of grain, or other cargoes that are approximately homogeneous. If properly qualified persons are intrusted with the assignment of load-lines, they will readily distinguish between vessels in which stability is likely to be a question of importance and those in which it is not. In cases where vessels will obviously admit of being loaded so as to become unstable at sea, the owners should be looked to for particulars of the stability, and for furnishing proof that, so far as stability is concerned, the vessel may be safely laden with her intended cargoes to the load-line given in the tables, or to such a reduced draught as may be considered proper. The responsibility of providing stability, or of showing that sufficient is provided, must be left with ship-owners. Stability is regulated by stowage; and no mere provision of freeboard, height of platform, or strength of structure, can make a ship safe if her stability is not secured by proper stowage. The regulation of stowage has but little more to do with freeboard tables than has the regulation of steam-power, bulkhead division, manning, and other essential elements of safety. Each of these points requires to be separately and fully dealt with."

Great importance is rightly attached by the Load-line Committee to the administration of the freeboard tables. The most perfect tables that can be framed must necessarily be incomplete in many particulars, and must leave much to the discretion of those who have to use them. The mere tables only apply to existing types of vessels; and out of those existing types they can only apply to vessels of high class which are in good condition. In the administration of the tables great discretion and knowledge are necessary, in order to use them with reasonable modifications, in view of changes in the types of ships, or of improvements in ships, that the continuous progress of naval architecture is certain before long to cause. The same discretion and knowledge are necessary in dealing with vessels which, by reason of age, structural defects, more or less rapid deterioration, or of anything that may be observed in their condition, cannot safely or fairly be loaded as deeply as vessels which are in first-class condition. The great majority of the members of the Committee are of opinion that, in order to give useful and satisfactory effect to the tables, the scientific staff of the Board of Trade should be strengthened, and should be made capable of dealing with all questions of such a nature that may arise, in a manner likely to command the confidence of ship-owners and of the public. They also think it essential that this work should be done under the superintendence of a representative body, which should consist not only of officials but also of ship-owners, naval architects, seamen, and perhaps underwriters.

Sir E. J. Reed said, "The Load-line Committee, in the inquiry which they undertook, had a very difficult task to perform. The origin of that Committee was this: the Legislature having placed the obligation of stopping the overloading of ships on the Board of Trade, that Department tried to do so, but failed to succeed, their interference being resisted by ship-owners. Thereupon Mr. Chamberlain conceived the idea of forming a Committee of gentlemen for the purpose of thoroughly investigating the subject, and seeing what answers could be given to the questions which had been referred to in the paper. The best proof that the Committee had done its work with a fair measure of success was to be found in the fact that no one had that evening complained of the results at which they arrived, which would not have been the case had mistakes been committed, as ship-owners never hesitated to defend themselves. Prof. Elgar had shown how necessary it was to supplement the labours of the Committee by further knowledge and investigation touching other elements of the safety of ships at sea. He believed ship-owners came out exceedingly well in the inquiry, both in the evidence they laid before the Committee and in the manner in which they applied their knowledge and experience to the investigation; and he should feel it his duty, when he saw Mr. Chamberlain, to point out to him that nothing could have been more fair-minded, more open or thorough, than the manner in which they co-operated with the other members of the Committee in bringing about the result which had been attained."

The public are indebted to the Load-line Committee for the satisfactory manner in which they performed a most difficult task; and especially to the Chairman, Sir E. J. Reed, to whose ability and good judgment the success of their labours may very largely be attributed.

THE WANDERINGS OF PLANTS AND ANIMALS

The Wanderings of Plants and Animals from their First Home. By Victor Hehn. Edited by James Steven Stallybrass. (London: Swan Sonnenschein and Co., 1885.)

THE title of this book is somewhat misleading, since it treats only of domesticated animals and cultivated plants, and of these solely in relation to European civilisation. The subject is treated as almost entirely a philological one, the origin of the several species and varieties being deduced from a study of their names in different countries and from a critical examination of the earliest references to them in ancient writers. The author's point of view is thus clearly stated in the preface:—

"The purely scientific man will judge chiefly by the suitability of soil and climate. If he finds a plant flourishing pretty abundantly in Greece or Italy now, and knows of no climatic or geologic changes that would exclude its having flourished there 5000 years ago, he will at once pronounce it indigenous, and scout the notion of its having been imported. But now listen to the scholar, and he may tell you that Homer never mentions such a plant; that later poets speak of it in a vague way as something very choice and very holy, and always in connection with some particular deity: they may have tasted its fruit, may have seen the figure of its flowers (probably conventional) in emblematic painting or carving, but have not the faintest notion of its shape or size, whether it be a grass, a shrub, or a tree; till at last, in the time of Darius or Alexander, the plant itself emerges into clear visibility. Your inference will be that it came to Greece within historic times."

In this way he claims to have shown "that the flora of Southern Europe has been revolutionised under the hand of man; that the evergreen vegetation of Italy and Greece is not indigenous, but is mainly due to the sacred groves planted round the temples of Oriental gods and goddesses; that in this way the laurel has followed the worship of Apollo, the cypress and myrtle that of Aphrodite, the olive that of Athena, and so on." But this very wide statement seems hardly to be justified by the evidence adduced in this volume.

As a good example of our author's mode of treatment we may refer to his account of the domestic cat. This animal, he shows, was quite unknown to the Greeks and Romans of the classical age. In the Batrachomyomachia the mouse tells the frog that he fears above all things the hawk and the weasel, but most the weasel, because it creeps after him into his holes. In "The Wasps" of Aristophanes a domestic story begins: "Once upon a time there was a mouse and a weasel"—just as we say to children, "There was once a cat and a mouse." In the fable of the City mouse and the Country mouse as related by Horace, the latter is frightened, not by a cat, but by the barking of dogs. In the original fables of Æsop, of Babrius, and of Phædrus, the cat is never mentioned, the weasel always occupying the place the former animal now fills in the house. No remains of cats have been found in Pompeii, though the bones of horses, dogs, and goats have been discovered, and some writers have imputed this to the superior intelligence and foresight of the former animal, which made its escape in time, whereas its absence is due to the fact that there were no cats in the city at the period of its destruction.

The cat was first domesticated in Egypt, and appears to have been introduced into Europe in the fifth or sixth century of the Christian era. It is first mentioned under its distinctive name, *Catus*, by Palladius, and somewhat later by the ecclesiastical historian, Evagrius Scholasticus. The author believes that the introduction of the cat followed the migration of the rat, *Mus rattus*, from Asia into Europe, where it seems to have been altogether unknown in classical times.

As an illustration from the vegetable kingdom we may take the discussion on the origin of the eatable chestnut. The name is traced to Asia Minor, and that it was not indigenous to Europe is shown by the fact "that neither Greeks nor Romans had an individual name for the chestnut-tree and its fruit." It is further argued that, "If the Greeks had found the chestnut-tree existing in their future country when they first arrived, they would certainly have mentioned the fruit in their legends. But we only hear of the acorns of the *drus*, the esculent oak; and the aborigines, such as the wild Arcadians in their mountains and woods, are always called *acorn-eaters*, even by the oracles. When Hesiod describes the blessings of peace and justice, the earth bringing forth fruits, the oak bearing acorns, the bees furnishing honey, and the sheep yielding its fleece—would he have forgotten to mention the chestnut, if it had then grown on the mountains, bestowing sweet fruit on mankind? And would the Latin poets, when describing the Golden Age, have limited themselves to mentioning arbutus-fruit, strawberries, cornel-berries, blackberries, and acorns? That the regions south of the Caucasus, and the northern seaboard of Asia Minor, bring forth all kinds of nuts and chestnuts in great abundance, is proved by the unanimous testimony of travellers, ancient and modern. . . . From these regions chestnuts came overland through Thrace, Macedonia, and Thessaly to Eubœa, after which island they were called Eubœan nuts at Athens."

The chief faults of this book are due to the want of any acquaintance with systematic natural history on the part of either author or editor. This has led to many errors of nomenclature and a most confusing arrangement of subjects. Beginning with a chapter on the horse, we pass on to the vine, fig, and olive, and then back to asses and mules. Then comes "stone architecture," followed by "beer" and "butter." After a number of vegetables, trees, fruits, and flowers are discussed, we come to fowls, pigeons, and other domestic birds; then more fruit-trees; then the cat and the buffalo, followed by the hop and grain-bearing plants. As illustrations of the want of some technical knowledge of natural history we have the prickly *Ruscus aculeatus*, instead of the glossy-leaved *Ruscus racemosus*, given as the Alexandrian laurel; the *cytisus* of the ancients, a shrub used extensively as fodder for cattle, and rightly identified as the *Medicago arborea*, confounded with the laburnum, an ornamental tree of a totally different character. The Virginian creeper (*Ampelopsis hederacea*) is confounded with another American plant, the fox-grape (*Vitis labrusca*), while the Lombardy poplar, a native of Western Asia, is said to have been brought from the Mississipi Valley.

Being evidently quite unacquainted with the discoveries of Darwin, the author greatly exaggerates the changes produced by man in the flora of Europe, considering it to offer a parallel case to that of St. Helena, where the indigenous vegetation has been almost wholly extirpated and replaced by plants from other countries. The incapacity of archaic insular forms to compete with the dominant races developed in the great continents is supposed to obtain equally in a portion of one of these ancient continental areas; and thus, the extensive development of certain useful or ornamental cultivated plants in Southern Europe is mistaken for the substitution of a new flora of a totally distinct type. That this is his belief is shown by the following passage:—

"Almost everything that strikes the northern traveller on crossing the Alps as novel and agreeable—the quiet plastic beauty of the vegetation, the characteristic forms of the landscape and animals, nay even the geological structure (in so far as it has become exposed by changes in its organic covering, and has then felt the effects of light and atmospheric agencies)—is a product of civilisation brought about by manifest transformations during long periods of time."

Notwithstanding a few blemishes such as those now indicated, the student of philology and of the early history of domesticated animals and cultivated plants will find this volume full of curious information; while there is so much discursive matter touching upon the primitive history of nations, their manners and customs, their arts and literature, and even their religion and philosophy, that the book will be interesting to a wide circle of general readers.

ALFRED R. WALLACE

EUROPEAN BUTTERFLIES

European Butterflies. By W. F. de Vismes Kane, M.A., M.R.I.A., Memb.Ent.Soc.Lond., &c. 8vo. Pp. i.-xxxi., and 1-184, with plates. (London: Macmillan and Co. 1885.)

IT has long been a standing reproach to British entomologists that they are mainly divided into two classes, those who collect or study British insects only, and those who, with little knowledge of the productions of their own country, are profound regarding exotics. In other words, continental Europe is a blank to the majority of them. And the purely "British" entomologist, as a rule, is supposed to look upon anything continental as unclean; yet nevertheless prizes any unusual species if captured on our shores, and uses every argument to prove that it may possibly be a true native, and not an immigrant, for if the latter there must be a certaint taint attached to it. The "purely British" entomologist is also supposed to endeavour to maintain his conservative ideas by refusing to enter into correspondence and interchange with his continental brethren, because everything not British is unclean. He retains a peculiar method in the preparation of his materials that renders them not only practically useless for purposes of study, but prevents them from being serviceable if by any chance they should fall into the hands of "foreigners." The writer has often been compelled to hear and to bear very strong expressions from his continental friends on this point. The writer has a book on *Lepidoptera* before him, and as nine-tenths of "British" entomologists confine their attention to *Lepidoptera*, the term "British entomologist" is here used in its narrow sense.

The time *will* arrive when we can safely say "*Nous avons changé tout cela.*" According to what we have observed during an experience of nearly thirty years, it is in rapid progress towards arrival, and that progress has been vastly accelerated recently. Many of our entomologists are expanding their ideas by continental travel, and latterly we have had from their pens several important indications that it is possible for British entomologists to know something about the productions of continental Europe, and even to endeavour to teach and lead their fellow-countrymen in the same direction. The thin end of the wedge naturally consists in popularising the subject.

The thin end of the wedge has been inserted, and it is being driven deeper to an extent that must create alarm amongst "British" collectors. There was a time when they had a nomenclature almost their own, and resented any attempt to upset it. Even this pet has been rudely insulted in the eyes of the most conservative in their number.

We have said that nine-tenths of our entomologists are probably Lepidopterists. The most attractive *Lepidoptera* are butterflies, and it is in this direction that the thin end of the wedge is being specially inserted. Almost within a year three works by British writers concerning European (as including British and continental) *Lepidoptera* have made their appearance. There are Lang's "Butterflies of Europe," and a re-issue of Kirby's "European Butterflies and Moths." Now we have before us Kane's "Handbook of European Butterflies." We welcome all as constituting the thin end of the wedge.

Mr. Kane's book differs in its plan from the works mentioned in connection with it. The only parallel to be drawn is with Kirby's "Manual," published nearly twenty-five years ago. Mr. Kane has produced a portable book that can, and should, go into the pocket of every entomological tourist. With no disparagement of the praiseworthy attempts of other writers to insert the thin end of the wedge, we incline to think this work will give it a sharper edge. So far as any work of the kind can be called a "handbook," this seems to be to the point. It is limited to the butterflies of Europe (geographically). The arrangement is that of Staudinger. The plan is to give concise descriptions of each species (in which abbreviations are freely, but intelligibly, used), notes on habits if known, and a copious list of localities; the latter is especially full for Switzerland, the south of France, and the Pyrenees, but wants enlarging for some other countries. When following Staudinger, the author should not have committed the error of wrongly designating *Papilio podalirius;* he overlooked the fact that Staudinger thought proper to correct himself in this case. It is not for us to compare the abbreviated descriptions with the insects; they bear the impress of being good. The introductory remarks are well considered: the endeavours to differentiate a butterfly from a moth might well have been modified; the distinctions have become so subtle as to rest more on intuition than anything else. Our author judiciously advocates the practice of placing the captured specimens in *papillottes* in the first instance, and fully explains the process. He does not appear to have remembered a suggestion by Dr. Jordan, to the effect that when the collector is *en voyage* a dozen specimens of the smaller butterflies may be placed in a pill-box, and both time and space be thereby economised (this would not answer in the case of exotic collectors). Our author evidently writes from personal experience, and is enthusiastic in his description of some of his excursions. His enthusiasm even carries him too far, for when he says: "Such days as these rise upon the memory like a reminiscence of Paradise, fraught with glories of colour, odour, light, and life," we are tempted to marvel why he again became mortal! The plates form almost a new departure in the method of illustrating works of this kind. There are 15, on which are about 130 figures. They are adapted from a peculiar photographic process. We have seen other attempts in this direction. Nothing can exceed the beauty and faithfulness of some of the figures in Mr. Kane's book; and here arises the difficulty: they are unequal, and so we fear will remain all attempts to apply photography where particular colours or shades are involved.

The author is responsible for the remarks on "preparation" that here precede the notice of the book itself. He avows himself personally in favour of setting his specimens flat (justly complaining of the imperfections of some of the pins used on the Continent), but advocates only half measures—a comparatively short pin on which the insect is to be set "half-way." This is a decided advance, and the practice is now often followed for British insects by the less conservative; but English pins (of the required length and not open to the objections stated) can be had, and on them the insects should be set in the continental fashion. Or continental pins would do equally well if used of a stronger size than is often done. The stronger the pin (up to a certain point) the more durable the specimen. The subject of pinning and preparation was thought not unworthy of forming the substance of the address of a recent President of the Entomological Society. Whether it was appreciated or not we cannot say, but if (as we believe was so) the writer of that address sought to destroy one of the greatest barriers that exists between British Lepidopterists (always excluding the thoroughly conservative irreconcilables) and scientific fraternity with the rest of the world, the subject was worthy of the occasion. R. McLachlan

ANALYTICAL GEOMETRY

A Treatise on the Analytical Geometry of the Point, Line, Circle, and Conic Sections, containing an Account of its most recent Extensions; with numerous Examples. By J. Casey, F.R.S. (Dublin: Hodges, 1885.)

Dr. Casey, by the publication of this third treatise, has quite fulfilled the expectations we had formed when we stated, some months since, that he was engaged upon its compilation. It is a worthy companion of those which have preceded it. It possesses many points of novelty, *i.e.* for the English mathematician. He has, from the first introduction of certain recent Continental discoveries in geometry, taken a warm interest in them, and in the purely geometrical treatment of them has himself given several beautiful proofs, and has added discoveries of his own, as we have already pointed out in our notice of the last edition of his "Sequel." We may here note that this last work has met with a very warm welcome in France and Belgium. The author himself has added so much in years now long past to several branches of the subject treated of in the volume under notice—the equation of the circle (and of the conic) touching three circles (three conics), and other properties—that he is specially fitted, by his intimate acquaintance with it and by his long tuitional experience, to write a book on analytical geometry.

The divisions are into eight chapters, the first of which, in four sections, treats of the Point, three sections being taken up with Cartesian and polar co-ordinates and the transformation of co-ordinates; the fourth section gives a brief account of Complex Variables, introduced by Cauchy in 1825, and extended by Gauss: "the introduction of these variables is one of the greatest strides ever made in mathematics." The second chapter, on the Right Line, treats it (§ 1) by Cartesian, then (§ 2) by trilinear, and (§ 3) by point and line co-ordinates; this last comparison is taken from Clebsch's "Vorlesungen der Geometrie." In Chapter III. four sections are devoted to the circle, § 2 being devoted to a system of tangential circles, § 3 to the "trilinear" forms of equations to the old circles and to all the recent circles; § 4 is devoted to tangential equations. Chapters IV., V., VI., VII. treat of, respectively, the general equation of the second degree, the parabola, ellipse, and hyperbola. Chapter VIII. (miscellaneous investigations) discusses many matters of novelty and interest: § 1 is on contact of conic sections; § 2, similar figures, gives a good *résumé* of results connected with Brocard's points and circles, Neuberg's circles, M'Cay's circles, and Kiepert's hyperbola (if upon the three sides of a triangle ABC similar isosceles triangles be described, the triangle formed by their vertices is in perspective with ABC, and the *locus* of their centre of perspective is an equilateral hyperbola); in § 3, on the general equation in trilinear co-ordinates, Aronhold's notation is "now published for the first time in an English treatise on conic sections"; the remaining six sections are occupied respectively with Envelopes, Projection, Sections of a Cone, Homographic Division, Reciprocal Polars, and Invariants and Covariants. An idea has now, we trust, been conveyed to the reader of the ground covered by Dr. Casey: a good deal of it is, of course, well-worn ground, but even this has been adorned by his touch, and much relating to the new circles has never before been introduced into our books. These circles must soon become as familar to our junior students as the nine-point circle, whose properties are by this time nearly exhausted.

The examples are exceedingly numerous, and a good feature is that most of the results obtained in them are numbered consecutively with the important results of the text: this enables the author to refer to them with facility. They exceed 600 in number.

There are several minor typographical inaccuracies which are easily corrected, but there are besides incorrect references to back articles and pages, which cause the reader some little annoyance in using the book: these can be easily rectified in a second edition (one on p. 150 gave us trouble, for Art. 23 read 21, p. 33).

It remains only to say that the expenses of the publication have been defrayed by the liberality of the Committee of the "Dublin University Press Series."

TWO YEARS IN THE JUNGLE

Two Years in the Jungle: the Experiences of a Hunter and Naturalist in India, Ceylon, the Malay Peninsula, and Borneo. By William T. Hornaday, Chief Taxidermist, U.S. National Museum, late Collector for Ward's Natural Science Establishment. (London: Kegan Paul, Trench, and Co., 1885.)

THE author of this somewhat ponderous volume was sent to India by "Professor" Ward, the well-known purveyor of natural history specimens at Rochester, New York, for the purpose of collecting various zoological desiderata, and especially skins and skeletons of the larger mammalia, and of crocodiles. The importance of this kind of collecting is greater than would be supposed by those who have no experience of its difficulty, and the task of securing specimens, and of preserving them so as to render them useful for scientific study, demands no inconsiderable amount of courage, perseverance, and knowledge. The majority of the skins and skeletons of the larger mammalia in European museums are derived from the specimens, generally dwarfed in stature, and very often diseased, obtained from menageries, and if these are to be replaced by the spoils of wild individuals, hunters who have a considerable knowledge of taxidermy must be engaged to collect. Many of the largest and most remarkable mammalia of the world are being rapidly exterminated, and before they share the fate of the dodo and *Rhytina* it is to be hoped that good skeletons, at all events, may be rescued for the study of future generations.

Mr. Hornaday is evidently an enthusiast in his art, and having greatly enjoyed both the sport of shooting wild animals and the process of converting elephants, tigers, orang-utans, crocodiles, and other formidable denizens of forest and swamp into useful museum specimens, he proceeds in the present work to give a full account of his wanderings and adventures during two years and nine months, the greater portion of which was spent in very wild parts of South-Eastern Asia and some of the neighbouring islands.

On the whole, and despite many shortcomings, both literary and scientific, the book is an agreeable account of an interesting journey, and scattered through the volume are many useful zoological notes. Amongst the most important of these are those referring to orang-utans, of which Mr. Hornaday obtained forty-three specimens, the majority shot by himself. He gives a series of measurements, which are particularly useful, of these and of several of the other mammalia which he obtained. He also describes the "nests," or rather resting-places, made by orangs, though the figure which he gives of one is unfortunately taken from an artificial imitation set up by him in the Museum at Washington and not from nature. The figure in question looks more like a gigantic crow's nest than the rough platform described at p. 403, and does not agree with the description. The curious proboscis monkey, *Semnopithecus* (*Nasalis*) *larvatus*, the Bornean gibbon, and several Indian and Ceylonese monkeys also furnish occasion for interesting notes, some of which are novel.

The greater part of the work is however devoted to descriptions of shooting wild animals, such as may be found in dozens of sporting books, or to accounts of the ordinary incidents of travel, and the book is prolonged by dissertations on the habits of animals, and on specific characters. Here the author is fairly beyond his depth. Chapter XX., for instance, is occupied with an account of the habits of the Indian elephant. Nearly the whole is compiled from Sanderson and other writers, and some of the statements thus copied are of very doubtful accuracy. Thus Schlegel's view that the Ceylon elephant is the same as the Sumatran, and distinguished from that of India by the number of ribs and dorsal vertebræ—a view long since shown by Falconer to be untenable—is stated as if it were an undoubted fact. Before, however, one has read much of Mr. Hornaday's work, it is manifest that the author's zoological knowledge is superficial and imperfect. At p. 14 the limestone of which the pyramids are built is said to be "full of nummulites, little flat echinoderms;" and at p. 72 we read, "unlike all other antelopes, the female gazelle possesses horns." Of course the author meant to write, unlike all other *female* antelopes, but this does not prevent the statement being a gross error; it might have been expected that any one writing on mammalia would be acquainted with such conspicuous instances of horned female antelopes as are offered by the eland and oryx.

It may naturally be inferred that the scientific names applied to animals by Mr. Hornaday are not always correct. For instance, at p. 107 he records the shooting in the Wynaad forest, Southern India, of a specimen of *Semnopithecus leucoprymnus*, a kind of monkey peculiar to Ceylon. The animal shot was probably *S. priamus*, of which there is a fine South Indian specimen in the Agassiz Museum, Cambridge, Mass., very possibly derived from Mr. Hornaday's collection, but wrongly labelled *S. entellus*. The circumstance that the Wynaad *Semnopithecus* is wrongly identified makes it probable that the Ceylon monkeys called *S. leucoprymnus* (pp. 268 and 277) were also *S. priamus*.

One point in Mr. Hornaday's favour it is only just to notice. His account, so far as it is possible to judge, is truthful. He may err in citing authorities who are incorrect, but his own observations appear trustworthy, and he records his failures with as much spirit as his successes. The illustrations are numerous and as a rule fairly good, if not always very artistic, but some of the views, and especially that of Ootacamund, opposite p. 96, give a poor, and not a very correct idea of the scenery.

W. T. B.

OUR BOOK SHELF

Traité de Zoologie Médicale. Par Prof. R. Blanchard. Part I. (Paris: J. R. Baillière et fils, 1886.)

IT is difficult to comprehend what is meant by medical zoology, but it is easy to take in the object and design of this manual. These are to give a general sketch of the structure and classification of the various forms of animal life, and to call the attention in some detail of medical men or students to those species, which are either useful or injurious to man. It would thus aim at combining an introduction to zoology with a short treatise on animal parasites and some notes on economic zoology. We doubt if in the pages of a small volume such a treatment of this vast subject could be satisfactorily carried out, and it speaks a great deal for the knowledge and tact of Prof. R. Blanchard, that he has, so far as we can judge from this first part of his manual, succeeded in producing a most readable work, which cannot fail of being attractive to the class for whom it has been written, and the knowledge conveyed in which is fairly up to a modern point of view. The manual is destined to form a volume of about 800 pages, illustrated by some 400 figures, which, for the most part drawn from original sources, are fairly reproduced. We note that at least in one case this reference to original figures has not been without its advantages, for the figures given by Saville Kent, in his manual of the Infusoria, of *Asthmatos ciliaris*, Salisbury, not being exact, have been misleading to others who have again reproduced them, and there can be no doubt that this so-called parasite, thought to be the cause of hay catarrh, is nothing but an isolated epithelial cell of the naso-pharyngeal passages. The references to authorities seem very complete, and the second part is promised immediately with a title-page and "les tables." May we hope that these latter will include an index of the species referred to, or at least of those the life-histories of which are given in detail. This would immensely increase the usefulness of the volume.

Microskopische Reactionen. By Dr. Haushofer, Professor am Technischen Hochschule, Munchen. (Braunsweig: Vieweg und Sohn, 1885.)

THIS book will be hailed both by the ordinary chemist, and also by the geologist, and also by the pharmacist, as a most valuable addition to our already very numerous books on chemical reactions or analysis. The object of the author has been to arrange in such a form as can be used in the laboratory, tests and reactions of a great number of substances which may be performed on very minute quantities, and the resulting bodies recognised by their characteristic forms under the microscope. As the author says, some substances are so easily recognised in minute quantities even in the ordinary way, like iron, iodine, or by spectroscopic means, as thallium or lithium, that recourse to the microscope is seldom necessary. But in the majority of cases, where small quantities have to be looked for, the style and general habitus of crystal produced either in precipitates or by evaporation from solutions, and especially their behaviour towards polarised light, gives most valuable indications of the presence of any metal, and where, as in most cases can easily be done, several salts are in this way compared, the results are quite as conclusive as with large quantities. The substances treated of are metals, non-metals, and acids, which are arranged for greater convenience of reference in working, in alphabetical order. The principal and most general forms of crystals are illustrated by 137 well-executed woodcuts.

A Bibliography of Protozoa, Sponges, Cœlenterata, and Worms; including also the Polyzoa, Brachiopoda, and Tunicata, for the Years 1861-83. By D'Arcy W. Thompson, B.A., Professor of Biology, University College, Dundee. (Cambridge: The University Press, 1885.)

THE importance of the well-known "Bibliotheca Zoologica" of Engelmann, with its immense and accurately-compiled supplement by Victor Carus, to the biological student need not be insisted on, and in the present work we have this record carried out to 1883 for the large groups of the Protozoa, Sponges, Cœlenterata, and Worms, including also the Polyzoa, Brachiopoda, and Tunicata. This volume of nearly 500 pages has been beautifully printed at the Cambridge University Press, and is one that will be a most handy work of reference to all students. In a short preface the author apologises in advance for possible deficiencies. It would be impossible to have a work of this sort free from omissions; but we have gone over very carefully the portion of the bibliography with which we were most familiar, and have been very much struck with its extreme accuracy. It is proposed to publish in the course of 1886 a supplement, to contain all detected omissions, and the author will gratefully receive any additional titles that may be sent to him. We would suggest that it might not add too much to the labour of preparing this, and that it would certainly add to the value of the supplement if omissions in Carus's volumes were also taken notice of, so that the bibliography of the groups now catalogued by Mr. D'Arcy Thompson should be fairly complete. This has been, we notice, already done in some instances in the volume before us. An index of authors' names would also be of use.

On the Ethics of Naturalism. (Shaw Fellowship Lectures, 1884). By W. R. Sorley, M.A. (W. Blackwood and Sons, 1885.)

THE theory of evolution has established its claim to having given the most satisfactory account of all forms of natural life, and Mr. Sorley endeavours here to show how it yields, by advancing it a step further, a complete explanation of human nature, mental as well as physical.

Whence, then, do human rules of action and aspirations for future right conduct come, and what sustains them? Mr. Sorley points out that happiness cannot *explain* the definite end of human action; it is only another name for it. Education and legislation combine to make the greatest happiness of the greatest number the desirable thing for each man's actions to tend towards, but there is little difficulty in pointing out the weakness of the theories of earlier writers who have tried, without the help of Darwin, Spencer, Galton, and others, to explain the feeling of duty; the feeling that we *ought* to do one thing rather than another when the former does not at the time seem so agreeable. We may quote Hobbes, for instance, who is unable to explain why any man feels any *duty* to his neighbour, and invents the fiction of the 'social contract"; and Prof. Bain, who has to account, by the associations of a few years, for the harmony of feeling between the individual and the whole. Evolution, of course, explains that although in the earlier days of the human race, each beneficial action sprang from egoistic motives, yet that the good result to the society has led to an inherited sympathy with such actions and such actors. There is the difficulty that since present ideas, according to the doctrine of evolution, are the latest outcome of all past experience, and what we are is the last result of all past influences, we seem to arrive at the very unprogressive conclusion that whatever is is right. And if, indeed, each man found that he had arrived at perfect harmony with all his surroundings, this would be the ideal state. This, however, is the case with none of us. Few of us but find the well-known utterances of the former and the "Video meliora, proboque, deteriora sequor" of the latter the counterpart of our own experiences, and still more easy is it to see how far from the present accepted ideals are all our neighbours. But as among all the slightly differing variations of a species there is a tendency to return to one type, so among all the contending inclinations and dispositions of the members of a race there abides an inherited code of morality, now become instinctive; one, as nearly fixed in each individual as the form of any species, but, like that, varying and developing in different individuals, families, and nations, and adapting itself to changed surroundings. These surroundings have always in human history been so different that the inborn or ideal code has not at any time become a general, still less a universal, one, and the struggles after holiness of the Hebrew, after beauty of the Greek, and after justice of the Roman, are still being continued in various proportions as modern times and conditions of existence have altered.

To some a morality never to be fixed will not appear a very steady one; a morality that is calculated to vary at different epochs and in different climates. Yet, surroundings always changing, man has to adapt himself to the change; always, therefore, will he be labouring towards a changed goal. Neither is it a cheerful prospect for the race. There will always be the "necessity for strong egoistic feelings and conduct in the struggle for existence, where the better-equipped organism asserts and maintains its supremacy only by vanquishing the organisms which are not so supplied." This struggle will continue on the highest levels of progress to which our race will reach; for "the multiplication of desires and of desiring individuals keeps so well in advance of the means of satisfying desires, that it is doubtful whether the course of evolution is fitted to bring about complete harmony between different individuals. It would almost seem that the 'moving equilibrium' in human conduct in which there is no clash of diverse interests cannot be expected to be brought about much before the time when the physical factors of the universe have reached the stage in which evolution ends."

Clark's Transit Tables for 1886. (London: E. and F. N. Spon, 1885.)

MR. LATIMER CLARK is still faithful to his self-imposed duty of enabling any one to obtain accurate time in any part of the world by means of the transit instrument, without any calculation. As in former years, Mr. Latimer Clark has now computed from the *Nautical Almanac* all the data necessary to enable this to be done for 1886. The author is doing a good work, for which every student of astronomy should thank him, for we have little doubt that most of those who procure a little transit instrument, and work it under Mr. Clark's able direction, will not end there.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Late Total Eclipse

ALLOW me to call the attention of such of your readers as are not already aware of the fact that the phenomena I mentioned in my notes of the late eclipse—the "pulsation" of the sun's light just before totality and the simultaneous "wave-shadows"—are recorded by Grant ("Hist. of Phys. Astronomy," p. 404) as having been witnessed in France during the total eclipse of 1842. He mentions several probable causes or contributing causes; among them the unsteadiness of the air, which certainly existed here. I have not been able to find these phenomena (or phenomenon with a double aspect) mentioned in any other work accessible to me, and should be obliged to you for a statement of the explanation now received. To an outsider the (apparent) rarity and local character of the phenomenon seem to cause this difficulty:—If it is owing to any cosmical cause, or one common to any large part of our atmosphere, it would seem that the phenomenon should be more widely seen; if, on the other hand, it is owing to the unsteadiness of the observer's atmosphere, should it not occur oftener?

Allow me to add that in suggesting in my notes that the small prominences I saw were "Baily's Beads" I was writing ignorantly, having been long under the impression that Baily's

Beads were a phenomenon of totality, and coloured; a reference to an elementary work showed me my error. What I saw was a row of small similar-looking and about equidistant prominences of a faint pink colour. A. S. ATKINSON

Nelson, N.Z., November 13

Brilliant Meteor

I CAN confirm Mr. M'Keague's statement regarding an extremely brilliant meteor observed by him on November 27, the train of which remained visible for fifteen minutes, for about 6 o'clock the same evening I saw, when near Edinburgh, the train of one very bright meteor (brighter than Venus) last for at least ten minutes. I did not time it exactly, but it could not have been less than that, and while it remained visible it kept curving round, and diffusing itself out into a thin cloud. About half an hour later I saw the train of another very bright one remaining and behaving similarly for about five minutes.

Broxburn, December 18 JOHN STEVENSON

Models Illustrative of Phyllotaxis

PROF. PARKER's note upon this subject induces me to mention a rough-and-ready contrivance, which I found serviceable when lecturing on this subject. This consisted merely of the framework of a collapsible opera-hat, or of two or three superposed. It is easy to attach stiff labels to these in any desired order, and easy to illustrate undeveloped or developed internodes, as the case may be. I have used the joints of an old telescope for similar purposes. Of course these are "makeshifts" only, but they are available when better things are not at hand. MAXWELL T. MASTERS

The Viper (*Vipera berus*, L.)

THE following letter, addressed to me by a most intelligent farmer, may be thought worthy of publication, as furnishing an additional item of evidence on a much-debated question.

"*Church Dale House, Egton, Grosmont, Yorkshire,*
November 10, 1885

"DEAR SIR,—In the beginning of the harvest of 1878 or 1879 I was with my late father, Mr. Thomas Stanforth, of Howlsike, near Lealholm, North Yorkshire, in a corn-field on the Howlsike Farm, when we noticed a large viper in a rough part of the field. My father exclaimed, 'Hold on, there's a hagg-worm,' and just at that moment the viper moved its head and hissed, when we both saw some ten or twelve young vipers glide into the mother's mouth. My father immediately crushed the head of the animal with his heel, and we laid it on a stone wall, intending to open it at our leisure. Proceeding to our work, this was forgotten, and I did not again see the viper until the following winter, when I found it still lying on the wall, but reduced to a skeleton. I examined it closely, and found many small perfect skeletons inside the larger one.

"In the summer of 1865 I saw a large viper opened, and a full-grown skylark taken out of its stomach.

"Yours truly,
(Signed) "ROBERT STANFORTH"

Much circumstantial evidence has already been printed on this alleged habit, and it is not unreasonable to suppose that the young reptiles, when disturbed, will rush into the nearest opening that presents the appearance of a place of refuge; but I do not remember to have seen any proof of the viper returning her young to liberty when the supposed danger was past. If they merely lodge in the gullet they can doubtless be ejected at will; if they pass into the stomach, their uneasy motions may act the part of an emetic, and produce nausea and vomiting before asphyxia sets in or digestion begins; and in either of these cases the action of the mother in permitting her brood to enter her mouth may be regarded as voluntary and instinctive. It is, however, possible that the young vipers may dart, uninvited, into the parent's mouth when it is opened in the act of hissing, and that they may quickly perish and be converted into food. We can only repeat the words of the late Prof. Bell, F.R.S., written thirty-six years ago:—"In this state of doubt upon so interesting a subject, it is perhaps better to await the results of direct experiment, which might be readily made in any locality where these reptiles abound" ("British Reptiles," 2nd edition, p. 69). R. MORTON MIDDLETON, Jun.

Castle Eden, December 10

Ventilation

MR. FLETCHER, of Warrington, ought to be an authority on such a matter as ventilation, and probably he has omitted in his letter to you some material points. I should like to know something of the supply of fresh air to the rooms where the ventilation failed. If that was abundant, then, it seems, there should have been an up-draught in each flue, though, as the current in the ventilating flues would have been less than in those of the chimneys, it would have been better if possible to have their outlets a little separate. If, however, the supply of air to the rooms were insufficient for the joint draught, then the ventilating flue (so called) would have become a down-cast shaft, and (owing to its situation) would have brought down smoke, &c., as described; and this insufficient supply, when the fires were lit and the ventilation shaft heated, might have been quite enough when there was no fire, or the chimney might have been the down-cast.

It has always seemed to me that this matter of air-supply is at the bottom of ventilation failures. The amount required is so large, that it must be warmed before entering a room in winter, but there are few houses where any provision is made for this. In fact, as matters stand, it seems to me that it would be nearly impossible to make satisfactory arrangements in most cases without great expense. No doubt the best arrangement would be to warm all the air, in one place, before entering the house, and to employ the fires or stoves in the rooms only to give locally greater warmth or brightness; but such an arrangement is so un-English that I suppose it must be rejected. Because our forefathers, when they first roofed themselves in, transferred their fire from the forest or cave to the middle of the hall, and then to the side with a chimney, we must follow the same practice; meanwhile closing up the inlets, which were plentiful enough in the early arrangement. We may be Radicals, but, like our ancestors, in most things, we do not wish to change the laws of England. J. F. TENNANT

37, Hamilton Road, Ealing, W., December 18

Snails Eating Whitening

I DO not know if the observation which is recorded below is new, but it is certainly new to me, and seems to be sufficiently interesting for publication. In the autumn of 1884 I noticed that the whitening which had been painted on some greenhouse glass in a garden at Reading, had evidently been eaten off by a large Gasteropod. The whitening was almost entirely removed from one pane, and partially from many others. The outlines of the parts which had been eaten were quite unmistakable, exactly resembling on a large scale the well-known traces left by freshwater snails on the conferva-covered glass of an aquarium. I did not find the snails at work, but the gardener assured me that he had seen them upon the glass, and that they were the common garden snails (*Helix aspersa*). Considering the entirely characteristic appearance of the marks, I think it may be taken as proved that the whitening was eaten by some large Gasteropod, and almost certainly by *Helix aspersa*. It is exceedingly probable that other forms of calcium carbonate (especially limestone rocks) are eaten in the same way, but the conditions of this particular form of the substance—spread out as it was in a thin film on a transparent layer—rendered the fact that it had been eaten especially conspicuous. As to the importance of calcium carbonate to the snail, it must be remembered that there is not only the necessity for growth of the shell in the young animal, and its repair in the adult; but there is also a regular periodical need in the latter for material to supply the place of the calcareous dart (*spicula amoris*), which is discharged before coitus, and is believed to act as an excitant in the sexual relations of these animals. The membrane (hibernaculum) which closes the mouth of the shell in winter is also to some extent calcareous.

December 14 EDWARD B. POULTON

Blackbird with White Feather

THERE is about my garden a hen blackbird with a white feather in the tail. I do not know whether this variation has been noticed before.

JOSEPH JOHN MURPHY

2, Osborne Park, Belfast, December 21

CYCLES

Variable Speed-gear

FIVE methods have been employed for making the speed of the wheels variable with respect to the pedal crank-axle whilst the tricycle is in motion, so as to vary the power to suit the nature of the road.

(1) A set of change wheels may be thrown in and out of action as desired.

(2) An epicyclic train may be used which for one speed is locked together and moves as a single piece, and is set in motion for the other speed. The well-known cryptodynamic two-speed-gearing was figured and described. In this an internally toothed wheel is keyed to the crank-axle. Connecting this and a loose pinion on the axle are four live pinions, the axles of which are attached to the chain-wheel. The internal wheel is fitted with a clutch, by which it can either be held stationary or keyed to the chain-wheel; when keyed to the latter the gear moves as one piece, and the higher speed is employed; when held stationary the live pinions roll round the centre wheel so that the chain-wheel travels less fast than the crank-axle, and then the greater power is obtained. This change can be effected by a striking lever.

(3) A third plan is to use two sets of chain-wheels and chains, either of which can be connected or disconnected at pleasure.

(4) Expanding chain-wheels can be used. Generally one only is employed and an idle pulley is provided for taking up the slack of the chain. A specimen was exhibited in which the pitch of the teeth is never altered.

(5) Another method of obtaining increased power is to use cranks with a variable throw. A diagram was shown of such a crank which could be changed in length by preventing it from rising by pressure when at the bottom of the throw; for at that time only is it free to turn on an eccentric, being locked by pawls and a gravitating bolt at any other position.

Position of Rider.—In every machine there is a certain position for the rider's seat, in respect both to the axle of the driving-wheel and to the crank-axle, which, on the level, will enable the rider to work to the greatest advantage. In ascending a hill the rider requires to be moved more forward, but he is in reality put further back, and the reverse is true when descending a hill. The most perfect contrivance for this purpose is the swing frame, which has been applied by Mr. Warner Jones to the Devon tricycle. The saddle and crank-axle are on the same frame, which is capable of rocking about the main axle and of being locked in various positions. By such means a rider is enabled to ascend a hill without leaning forward in the usual manner. A modification of the same arrangement by Mr. Griffiths was referred to.

Another method of varying the position depends on the use of a sliding base to the saddle-spring, which may be actuated by a lever and locked in one of three positions.

Hand-power Tricycles.—A few machines driven by the arms instead of by the legs have been made, but from the greater weakness of the arms they cannot compete with ordinary cycles, but are suitable only in special cases. Two machines, the Velociman and Oarsman were described. In the Velociman a pair of hand-levers are connected to the cranks of a second axle, which drives the main axle by a chain as usual, differential gear being employed to actuate the wheels. The rear steering-wheel is actuated by a lever carrying a cushion, which can be moved by inclining the body. In the Oarsman the action is similar to rowing. The rider sits on a sliding or a rocking seat, and pulls a cross-bar which is attached to a pair of driving ends which pass over pulleys connected with the driving wheels by clutches. During the return stroke the pulleys have their motion reversed by a spring.

[1] Continued from p. 135.

Sociable Tricycles.—Of tricycles for two riders those in which the riders sit side by side are called Sociables, and those in which one is in front of the other, Tandems. The Sociable is merely an enlargement of the single form with some part in duplicate. Some can be converted into a single machine. In the Coventry rotary Sociable, since four wheels are on the ground, a joint has to be introduced to allow for the inequalities of the surface. In this machine each rider drives the wheel on his side only. An ordinary front-steering pattern of convertible tricycle was figured, in which, when one wheel is removed from the single form a second half-frame can be bolted on, while the axle of the added part is fitted where the wheel was removed, and the crank-axle of the added part is bolted to the crank-axle of the single part; thus the two riders drive through the same chain the box of the differential gear which drives each wheel equally.

Tandem Tricycles.—In these there is more scope for variety, and the different machines may be classed as follows:—

(1) The ordinary front or rear-steering tricycle in which the wheel-base is extended, so that the riders may be seated fore and aft of the differential-geared driving-axle without destroying the balance of the machine.

(2) The Humber tandem, in which the extra rider is seated in front of the driving-axle, but as nearly over it as possible, and communicates motion to it in a similar manner to the rear rider, who is seated further back than in the single machine so as to counterbalance the extra weight in front.

(3) A machine in which an auxiliary trailing frame is fixed in the rear of an ordinary front-steering tricycle. In order that the trailing frame may rise and fall with the inequalities of the road, and may follow properly when the machine is running round a curve, it is necessary for it to have both a transverse and a vertical joint between the two frames. A figure was given of a trailing frame with a chain to drive its own wheel which could be clamped to the back of any front-steering tricycle. With this arrangement there is no necessity to take off a chain when detaching. A special detachable chain for convertible tandems was shown.

Carrier Tricycles.—The most useful kind of tricycle of all is that for carrying a burden. First the "Coventry Chair" was exhibited. This consists of a Bath-chair in which the large wheels are driven by a rider at the back in the same way as the wheels of a tricycle. The driver also controls the steering and manipulates the brake. The passenger sits in a comfortable wicker chair. Though these machines cannot be driven with the freedom of an ordinary tricycle, yet when their weight and the fact that there is a passenger on board is considered, they travel with marvellous ease. Examples of journeys made were given.

Of goods carriers there are a large number of makes, but there is nothing in their construction to call for special comment; their success depends chiefly on the load being balanced as much as possible on the driving wheels. They are largely used by the Post Office for the parcels post, for the delivery of letters in rural districts. They are also largely used by newspaper offices for the distribution of papers, and by tradesmen for the delivery of goods.

Arrangement of Driving Gear.—Tricycles driven by rotary action may be subdivided according as the differential gear-box is in the centre or on one side, and according as the driving chain is in the centre or on one side.

In side-driving tricycles the loop frame is generally employed and the gear-box may be either at the centre or the side.

In central-driving tricycles the frame is usually of the T pattern. Here again the gear-box may be either at the centre or the side. Theoretically there is an advantage in the central position of the gear-box, as the friction due to the bearings is equally distributed between the two wheels, whereas with side-gear one wheel only is retarded by this friction, but practically the difference is inappreciable. In central-driving machines the bearings must be so distributed as to prevent the main axle from bending under the pull of the driving-chain. The advantages of the T frame are its simplicity and lightness and the possibility of using adjustable cranks.

Width.—As the width of a tricycle varies between thirty-six and thirty-nine inches—excepting the Coventry Rotary, which from its special design can be made as narrow as twenty-seven inches—many arrangements have been devised for temporarily reducing the width, so as to enable a machine to pass through an ordinary doorway. Two plans only call for special notice, namely, folding frames and telescopic frames. A folding frame, when one or more pins are removed, can be folded up, but can still be wheeled along. In telescopic frames, which are always used with central-gearing, the frame and the axle on one side of the machine are made telescopic, so that by slackening a nut the parts slide over one another. A telescopic axle was shown.

Weight of Tricycle.—The proportionate weight of the several parts of a loop-frame front-steering tricycle were given.

Component Parts of Cycles

Of the component parts of modern cycles the following alone call for special notice: wheels, bearings, frame, steering-gear, brake and pedals.

Suspension wheels, the first great improvement in cycle construction, are made with either solid or hollow rims, the latter being the lightest and strongest. In an ordinary wheel the spokes are radial; they are threaded through holes in the rim, and screwed into the edge of the flanges of the hub, being butt-ended or enlarged where the thread is cut upon them. The section of the rims is crescent-shaped. Hollow rims are made either from a tube by rolling it to form, or out of a single strip of steel plate bent to the desired section, in which case the edges lap over one another and are brazed together; or out of two or more strips of metal bent to form and brazed or sweated together.

Round rubber tyres are used, but with surfaces sometimes corrugated longitudinally, which gives a better hold on the road. The outer surface of the tyres is sometimes made of harder rubber to diminish the wear, while the elasticity of the inner and softer rubber saves the jolting of hard rubber alone. Tyres are usually fixed by cement, which when properly done is sufficient, but a wire passing through the centre of the tyre is used by some.

Tangent spokes are employed to give extra torsional rigidity to the wheel. The spokes, instead of being radial leave the hub nearly at a tangent alternately in opposite directions; sometimes a single piece of wire is threaded through the flange and the two ends made fast to the rim by nuts, but in that case they invariably give way first at the point of the double bend. Headed spokes passing transversely through the edge of the flange are now used.

One of the latest innovations in the construction of wheels consists in corrugating the spokes throughout their entire length, which gives a certain amount of elasticity to the wheel. At first sight it would appear that these corrugations should seriously diminish the lateral stability of the wheel; but as far as experience shows such is not the case. As, however, wheels so constructed have not been very long in use, it remains to be seen whether they will stand the wear and tear of the road.

Bearings.—The bearings of the wheels are now almost without exception made with anti-friction balls interposed between the moving parts. The most approved kind is that known as the Æolus, which can be adjusted concentrically. The balls lie round a groove on a collar on the axle, on the two sides of which they bear. They are enclosed within a concentric casing composed of two pieces, one of which screws within the other. Each of these has a hollow conical surface, between which the balls are free to run. One piece can be screwed in until there is as little shake as may be desired, and it may then be locked in position by a small toothed bracket. A diagram was given showing the section of the usual small wheel bearing also capable of concentric adjustment. The results of the experiments made by Mr. Boys on the wear of balls in ball bearings were given. He found that in running 1000 miles each ball lost in weight only 1/250 grain, which is equal to an actual surface wear of only 1/158,000 inch.

Frame.—The frames of both bicycles and tricycles are largely constructed of weldless steel tube. In the bicycle the front fork is made of tube tapered and worked into an oval section so as to give the greatest possible strength to withstand the severe torsional stress to which it is subject. The back-bone is left round, but is tapered, while the hind-wheel forks are usually made from a stamping in sheet steel.

The hollow framing of tricycles is usually circular, having a diameter of from 1 to 1¼ in. and a thickness of from 0·065 to 0·095 inch. The large number of solid parts necessary are usually made from wrought-iron or steel stampings. Malleable-iron castings are also largely used and are the cause of many of the breakdowns of machines. Owing to the great expense of dies the temptation to use these is strong. This expense, combined with the fact that the patterns of tricycles at present are frequently being changed, is the cause of the present high price of first-class machines.

Steering-gear.—The steering-gear may be dealt with under two heads: (1) the method of mounting the steering-wheel so that it may be turned for the purpose of steering; (2) the method of controlling the wheel.

(1) The steering-wheel of all bicycles and of most tricycles is mounted in a fork, at the top of which is a "head" by which the fork is attached to the frame. In the head is the joint to allow the steering-wheel to be turned. The "Socket" and the "Stanley" head were described and a figure given of an improved "Stanley" head in which, instead of cones, balls are used to allow of free motion between the head and the central pin. A figure was given of another form of Stanley head in which a central pin is employed.

The steering-wheels of tricycles are not always mounted in forks. Among other methods that employed in the "Quadrant" tricycle was described, and another in which a large skeleton hub carries within it a small head actuated by a lever from the outside.

(2) On an ordinary bicycle the steering is controlled simply by a handle bar rigidly fixed to the fork.

Tricycles have their steering actuated usually by the rack and pinion; a handle-bar as used on a bicycle is also employed either connected directly with the fork or through levers.

Owing to the sensitiveness of this mode of steering, mechanism has been contrived which tends to keep the steering-wheel to a straight course. The most effectual is that employed on the Humber make of front-steering tricycle. A V-shaped cam on the steering-rod lies in a corresponding recess on the top of the socket of the steering-spindle and is held down by a spring. When the machine is steered the spring is compressed by the action of the cam, and so it tends to bring the wheel back to the straight line.

Brake.—There are but two varieties of brake; the spoon- and the band-brake. The spoon-brake consists of a spoon-shaped lever so pivoted that it can be pressed against the tyre of the large wheel in the bicycle or the two wheels of a tricycle.

The band-brake, almost exclusively used on tricycles, consists of a band of steel lined with leather encircling a drum in the driving-axle. By a hand-lever this can be tightened with great foree. In some central-geared tricycles a band-brake can be applied with the foot to the crank-axle.

Pedals.—When bicycle cranks are used the pedals are mounted on pedal pins bolted to the cranks. With cranked axles they are made in two halves. Ball bearings are frequently employed. Both rat-trap and rubber pedals are made: the latter are more slippery than the former, but absorb more vibration and so are more comfortable. The combination pedal with rat-trap plates on one side and rubber on the other is due to the author. A common cause of danger in bicycle riding is the slipping of the feet from the pedals when driving with much power, which puts the weight so far forward as to throw off the rider in front. Pedals to grip the feet have been devised, but some forms are apt to hold the feet so firmly as to make a sudden dismount occasionally impossible. The author has invented a pedal in which by bell-crank levers the foot is only held when pressure is exerted.

Fittings, &c.—Of the fittings and accessories the varieties are far too extensive for enumeration; but many display an amount of ingenuity that will well repay an inspection of them. The manufacture of these fittings forms separate trades, which employ a large amount of capital and labour.

The Chairman having complimented the author on the excellence of his paper, invited discussion.

Mr. C. Vernon Boys, referring to the undoubted going powers of the small Safeties, thought that in addition to the reason given in the paper the facts that the wind resistance was enormously reduced and that the rider could work in a position of comfort, without straining himself to ride as high a wheel as possible, had a great deal to do with the observed result. He thought that on a racing path the wind resistance of the spokes was the chief opposition to the motion of the machine.

He pointed out that the method of turning the Otto as described by the author, though employed by some, was essentially bad, tending to rub the tyres off one of the wheels, and explained the perfect method by which the wheels are made to turn simultaneously in opposite directions, by which no strain is put upon the tyres and only half the space is required for turning.

He thought too much preference had been given the clutch as compared with the differential gears for driving tricycles, and pointed out that in starting round a curve owing to the fact that the wrong wheel—the inner one—alone drives, more strain is thrown upon the steering-wheel, causing it to slip, than it ever experiences in ordinary riding when one wheel of a differentially-geared machine meets with greater resistance from mud or other causes than the other.

He mentioned the fact that Mr. Burstow, the inventor of the centre-cycle, had shown him nearly two years ago a double-acting clutch such as the author considered to be even more perfect than the differential gear, but he did not know how it was constructed.

Passing on to the Oarsman tricycle, Mr. Boys said that though apparently a hand-worked machine it was in reality driven chiefly by the muscles of the legs and body, and the stroke was only completed by the arms; and also that though a clutch-driven machine it had the advantages of a differentially-geared machine, in that when turning a corner the two cords could be pulled to different extents, and each wheel could at all times be driven.

He gave his experience of the elastic spokes. Since Christmas he had ridden a pair of wheels 3,800 miles, and had tested them most severely, but as yet they showed no signs of becoming untrue or losing their elasticity.

He had made further tests of the wear of balls, letting them run 1000 miles without being opened, after which he found that the wear was about one-fifth the rate of that previously observed. This, he considered, went to show that the wear, such as it was, was almost entirely due to a very small amount of grit which it is impossible to prevent from entering the bearing from the screw however carefully it may be cleaned. However, the result last obtained showed that the loss of weight of each ball in travelling 1,000 miles, during which it turned on its own axis about 1,400,000 times was less than 1/1000 grain. This, he thought, showed that those who found fault with ball bearings did so very rashly.

Mr. Sampson referred to a machine shown at the Inventions Exhibition on the lines of the Otto, but driven with a chain and with definite worm-gear for steering, which was worthy of attention.

Mr. Dalby, speaking as a rider, said he was sure that the author of the paper had not set the invention of the balance gear at its true value, that he had done special pleading on behalf of the clutch system. After severely criticising the arguments of the author, he attributed the poisibility of the modern tricycle mainly to the balance gear.

Mr. F. Warner Jones thought that more might have been said on the principles of cycle construction. The paper had been mainly descriptive of machines, and very little of first principles was to be found in it.

He agreed that the wind resistance was so much less felt on the small safeties than on a full-sized machine, that this should be considered an important factor in the cause of their good qualities. But he did not quite agree with Mr. Boys as to the way in which this acted. In any case the seat must be about seven inches behind the pedal axle to enable the rider to work in a proper position. With a saddle so placed on an ordinary bicycle the position became dangerous when descending a hill, but owing to the construction of the safety bicycles this position could be attained with perfect safety, the rider being more between the wheels. On a high machine the wind acted with a greater leverage, throwing more pressure on the hind-wheel in proportion than in a Safety.

The Safety bicycles with the steering-wheel in front were safer than the others owing to their greater length, and the fact that the rider was so far back, but they were not so fast, as less weight was on the driving-wheel. The rider could not be placed far enough back to put as much weight on the driving-wheel unless the pedal axle were divided. By adapting the swing frame with the divided pedal axle to such a class of machine, as much weight as desired could be placed upon the driver, and the advantages of the dwarf bicycles and of the Otto secured in one machine.

Concerning the Otto there seemed an anomaly—that they were better hill climbers when the wheels were as high as 56 in. than when smaller. As it was necessary for the centre of gravity to be over the points where the wheels touched the ground, there was a limit to the steepness of hill which could be surmounted.

He quite agreed with Mr. Boys as to the good qualities of the elastic spokes. He considered they were correct in principle.

Mr. Boys showed that even in the case of the steepest hills the amount by which the points of contact of the wheels with the ground were advanced was so small as to produce none of the effects supposed by Mr. Jones. In fact the hill-climbing power of the machine was perfectly well known.

Mr. Phillips felt sure that the slow pedalling was a far more important factor than the diminished wind resistance in the cause of the excellence of the Safeties. He had not intended to represent that the clutch gear was as good as the differential, but that at present the differential was greatly superior; he however believed that some device of the kind that he had spoken of—a perfect and instantaneous double-acting clutch—would be better than either.

He had not seen Mr. Burstow's clutch mentioned by Mr. Boys.

In speaking of the loss of power due to perpetually bending steel driving bands he did not refer to the very thin bands of the Otto, but to driving bands with holes to fit over pins some four or five times as thick.

The Chairman considered it an open question whether the path of a bicyclist were really wavy as theory seemed to show. He had often watched a bicyclist and it was almost impossible to believe that he did not travel in a straight path. He thought this question worthy of more attention. He had heard it asserted that no advantage could be gained by the use of artificial cycles over natural legs, but it must be remembered that legs were implements fitted for other purposes besides running, such as jumping and climbing. Again, no one supposed that a horse could carry on his back such a load as he could easily draw in a carriage on a road; here the extra weight of the carriage corresponded to the addition of the bicycle.

As in many other industries, bicycle and tricycle construction depended to a large extent for its success upon the perfection of many details of construction; as instances of important details he referred to rubber, steel wire, steel stampings, and driving-gear. Having made some remarks on the necessity of good roads he expressed the opinion that in time cycle ways might be laid down with advantage.

It was a mistake to suppose that cycling was only suitable for the young and active; people of all ages and conditions might enjoy the benefits of the wheel. The advantage of a sound machine to a labouring man, or of a hand-driven machine to a lame man, was inestimable, while invalids could even enjoy a run to the seaside in a Coventry-chair without the annoyance of cabs, railway stations, and trains. Having proposed a hearty vote of thanks to Mr. Phillips for his paper, he brought the proceedings to a close.

ALFRED TRIBE

ON November 26 died, after a very short illness, Mr. Alfred Tribe. He was born in London forty-six years ago in humble circumstances, and his first acquaintance with science seems to have been obtained as a boy at the Royal College of Chemistry. While waiting upon the students there he acquired whatever knowledge he could, and repeated in a back kitchen at home many of the experiments he had seen them perform. Prof. Hofmann, pleased with his desire for knowledge, gave him every encouragement and assistance in his power. At the age of sixteen he entered into the service of Dr. Medlock, then of Dr. Forbes Watson, and afterwards he assisted Prof. Williamson, of University College. He then went to Dr. Bernays, who after some time induced him to spend a year at Heidelberg under Prof. Bunsen, and kept his place at St. Thomas's Hospital open for him while he was away. On his return he continued to act as laboratory assistant and Demonstrator of Chemistry.

Twenty years ago he became my private assistant, and remained head of my laboratory till his death. During the same time he held the Lectureship on Metallurgy to the Medical School of the National Dental Hospital, and since 1874 he has been Lecturer on Chemistry and Director of Practical Chemistry in Dulwich College.

He became successively a Fellow of the Chemical Society, of the Institute of Chemistry, and of the Society of Chemical Industry.

Mr. Tribe was pre-eminently a scientific investigator. He loved patient and original research, and all his work was most carefully and honestly done. He published a large number of papers, some in his own name, and others in conjunction with myself. His first paper was on Sulphide of Ammonium, his second on the Expansion of Bismuth at the Freezing-point. His more important inquiries were connected with the occlusion of hydrogen by copper and the rarer metals, and especially a series of experiments on the distribution of the electricity in an electrolyte traversed by a current. The curious and suggestive results of this investigation appear in abstract in the *Proceedings* of the Royal Society for January and June, 1881, but they are most fully expounded, with coloured illustrations, in the second edition of Mr. J. E. H. Gordon's Treatise on Electricity and Magnetism."

His most important research in conjunction with myself is contained in a series of papers on the Copper-Zinc Couple, published principally in the *Journal* of the Chemical Society. He was the first to observe the greatly enhanced chemical power of zinc when covered with spongy copper. Whatever value there was in this extended research was due to his original suggestions, as much as to his careful manipulation. The same credit is due to him with regard to the series of papers on the aluminium-iodine reaction, the last of which was read only the night before he was taken ill. His discovery of these two new methods of acting upon chemical compounds was productive of many new substances, including the aluminium alcohols.

In addition to these chemical inquiries, we worked together on some electrical matters—describing an air-battery, that is, one in which the oxygen of the air took part; some experiments on thermal electrolysis; and, more particularly, the chemistry of the secondary batteries of Planté and Faure. The results of this investigation were first made known through the pages of NATURE, and were afterwards collected together in a separate treatise.

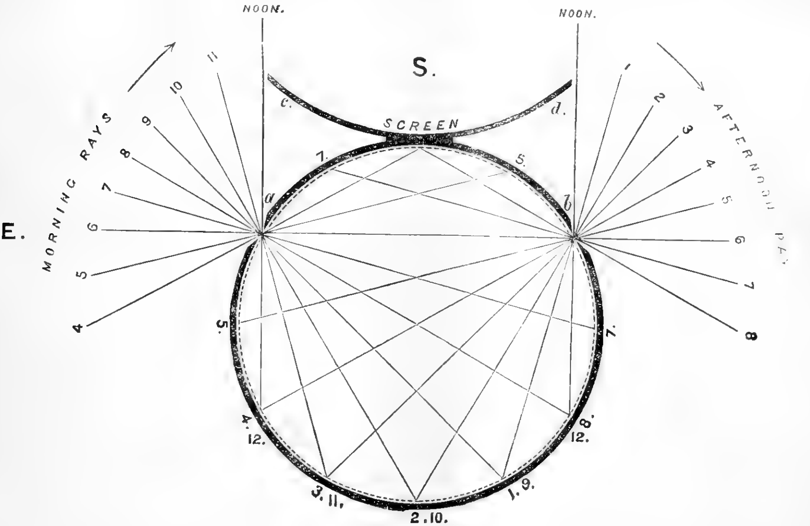
As a teacher of science, Mr. Tribe was very successful. He had the art of communicating his own enthusiasm to his laboratory students, and many of them have distinguished themselves since at the Universities or elsewhere. Only the week before his death he had the satisfaction of knowing that his favourite science was to receive a more worthy share of attention in the Dulwich College.

At these pursuits Mr. Tribe worked earnestly and continuously, being little known beyond his laboratories and his home. His widow, and four surviving children, together with a small circle of intimate friends, will however long remember the thorough uprightness of his character, and the self-denying purpose of his life.

J. H. GLADSTONE

JORDAN'S PHOTOGRAPHIC SUNSHINE RECORDER

UP to the present time the only instruments in general use for registering the duration of sunshine are modifications of the original apparatus invented by the late Mr. J. F. Campbell, of Islay, in 1853, the essential part of which consists of a clear glass globe capable of condensing the solar rays sufficiently to burn a trace on a card placed within its focal range. New forms of instruments have, however, been lately devised, and in the International Inventions Exhibition there were exhibited two Sunshine-recorders differing entirely from those hitherto used, the results being obtained by means of photography. Prof. McLeod's instrument was described in NATURE (vol. xxxi. p. 319), and we now give particulars of Mr. Jordan's photographic Sunshine-recorder. This instrument is of very simple construction. The working part consists of a cylindrical box or dark chamber $2\frac{1}{2}$ inches diameter and $3\frac{1}{2}$ inches long, mounted on a suitable stand having the means of adjustment to suit the latitude of the station where used. This cylinder is pierced with two small rectangular apertures or knife-edged slits, and, being placed in a position facing south, the rays of sunlight pass directly through these apertures and are received on the sensitised surface of a photographic paper or chart placed inside. By reason of the earth's rotation, the spot of sunlight thus obtained travels over the chart in a more or less curved line (according to the season), marking its path by a clearly-defined blue trace, which can be rendered permanent by simply immersing the paper for a few minutes in cold water. The position of the sun in relation to the instrument at the different hours of the day will be understood by reference to the figure, which is a cross-section through the cylinder; the dotted circle shows the position of the prepared chart, The screen, *c d*, is for the purpose of cutting off the rays from the eastern aperture at noon, and at the same time



allowing them to pass through the western aperture; it also forms a protection from rain and diffused light.

Observations made with this instrument prove that photography is well adapted for recording the duration of sunshine, and under some conditions it has advantages over the burning method. At those times when the atmosphere is perfectly clear the two methods give similar results, but when the sun is partially obscured by haze or thin cirrus cloud there is a difference in the records obtained. The result of a month's comparative observations, taken in June last, gave an excess of 11 per cent. of sunshine recorded by the photographic process, this variation being mainly due to a hazy atmosphere near the horizon about the times of sunrise and sunset.

METEOROLOGY IN THE NEW ENGLAND STATES[1]

THE New England Meteorological Society was founded in June, 1884, with a membership of 9, which at the close of its first year had risen to 95. Notwithstanding this very modest commencement, it has succeeded, largely through the generous co-operation of friends who have from time to time contributed liberally to its resources, in keeping its expenses within its income, while at the same time it has regularly published its *Monthly Bulletin* of eight pages, including a weather-map for the month; largely added to its observing stations; and largely extended the sphere of its operations. The annual fee for membership, which constitutes the whole income of the Society, is three dollars.

During its first year, ending last October, the Society has addressed itself more particularly to the securing of a corps of reliable observers of meteorological phenomena, with special attention to rainfall and temperature; the publication of the *Monthly Bulletin;* the dissemination of the daily indications of the U.S. Signal Service; the local display of weather-flags; and the special investigation of thunderstorms. The first number of the *Bulletin* contained reports from forty-five observers; but, so vigorously was this important branch of the Society worked out, that in September the number had risen to 123 observers. The greatest attention has been given to secure uniformity in the instruments and methods of observation. In the last-published *Bulletin* the amount of precipitation and the mean temperature are given in Table I. for thirty-five places, these being at the same time compared with the averages of previous years, which range from eleven to seventy-four years. Table II. gives a succinct summary of the results of the observations of temperature, pressure, humidity, and precipitation at the 123 stations, and the weather-map shows graphically the precipitation and range of temperature for the month.

A striking feature of the Society's work is its hearty co-operation with the U.S. Signal Service in the dissemination of daily forecasts of the weather, and the local display of weather-flags. A member of the Signal Corps has been assigned to this duty under the Society's control, with the gratifying result that local weather flags are daily displayed in upwards of 100 cities and towns of New England.

The special investigation of thunderstorms has been conducted under the supervision of the Secretary, Mr. Well

[1] *Bulletin* of the New England Meteorological Society, Nos. i. to xii. Nov. 1884, to Oct. 1885).

Davis, of Harvard College. The National Academy, which constitutes the trustees of the Bache fund, has granted 200 dollars for this work. Upwards of 400 observers are co-operating in the inquiry, and as regards one thunderstorm reports from 203 observers were received. The discussion of the important results already obtained will by and by appear in the *Bulletin*. A thorough investigation of thunderstorms, including the falls of rain, snow, and hail, with their successive propagation over the New England States, will be a highly important contribution to meteorology; and for the results of the investigation as it advances we shall look with much interest to the proceedings of this Society, which is among the very youngest but most active of the meteorological societies.

NOTES

We much regret to record the death of Sir Frederick J. O. Evans, R.N., K.C.B., F.R.S., late Hydrographer of the Admiralty, in his seventy-first year. Next week we hope to give a notice of Sir Frederick's career.

His Excellency the Minister of Agriculture, Industry, and Commerce in Italy, in order to favour and facilitate the application of remedies in solution, powder, or mixture against the cryptogams and parasites of cultivated plants, and especially the use of milk calx against Peronospora (mildew) of the vines, by a decree of November 9 will open an International Exhibition with prizes for pumps, watering and pulverisation implements. The Exhibition will take place at Conegliano in the Royal School of Vine-Culture and Œnology. The following prizes will be awarded:—1 gold medal and 500 lire; 3 silver medals with 150 lire each; 5 bronze medals. The Ministry of Agriculture will also purchase prize implements to the value of 1000 lire for distributing to the Agrarian Government depots, practical and special agriculture schools. Exhibitors must apply for admission to the "Direzione della R. Scuola di Viticoltura ed Enologia in Conegliano" not later than February 22, 1886. The demand must contain a short description of the instruments and the price of each object to be exhibited.

It is stated that the Mexican Government are about to establish a meteorological station among the highest mountains in Mexico, at an elevation of nearly 20,000 feet above the sea-level. Access to such a place must be always precarious, and frequently impossible for a long time together, hence it is necessary to make exceptional provision for rendering the instruments almost independent of human attention and supervision. The necessary apparatus is being constructed by Hottinger, of Zurich, and, as far as possible, all the instruments are being made to go for a year without stopping.

At the monthly meeting of the Council of the Sanitary Assurance Association arrangements were completed for the series of free lectures to be given by the Association at the Parkes Museum during January and February next. The first lecture is to be by Prof. Roger Smith, on "A Damp House," on Wednesday evening, January 20, and on the following Wednesday Mr. F. B. Jessett, F.R.C.S.Eng., will lecture on "Preventible Diseases."

The science certificates and prizes obtained by the students attending evening classes established by the Birmingham School-Board were distributed by Prof. Lapworth, LL.D., F.G.S., in the large hall of the Icknield Street School, on December 14. The report of the year's work, by the Board's demonstrator, Mr. W. J. Harrison, F.G.S., showed that some 5000 children are now receiving elementary instruction in science in the day-schools, while 500 teachers attend the evening classes. Prof. Lapworth afterwards delivered a very able and scholarly address. In consequence of the rapid growth of the system of science teaching, the Board has just resolved to enlarge the chemical laboratory at a cost of about 700*l*.

The Clothworkers' Company have promised to raise their annual subscription to the City and Guilds of London Institute from 3000*l*. to 4000*l*., provided the Corporation and Associated Livery Companies raise the total of their annual subscriptions to the Institute from 24,500*l*., the present amount, to 30,000*l*. This is probably the first step in response to Lord Selborne's recent appeal to the City Companies, on the double ground of public duty and self-interest, to add still further to their already munificent contributions to technical education. The capital expenditure on the building and equipment of the Central Institution, Exhibition Road, the Finsbury Technical College, and the South London School of Technical Art has been nearly 140,000*l*., but, as the late Lord Chancellor pointed out, the Companies cannot be said to have discharged their obligations to technical education, until the Institute wants no more pecuniary support and moral countenance. Until this distant goal is reached, said Lord Selborne, they remain in its debt, notwithstanding their already vast donations.

The statement, according to *Science*, that one of the chief applications of composite photography will be in the direction of producing more reliable portraits of representative men by combining the testimonials of individual artists, will probably be accepted by all who have followed the short but interesting career of this new invention. The suggestion that, by combining the individual conceptions of several artists, one would obtain a more reliable portrait than any of the components, was near at hand. The first such application was made by Mr. Galton himself. He made a composite of six medallion heads of Alexander the Great, and naturally claimed for the composite the combined authority of all the artists. In this way *Science* has recently come into possession of a new Shakespeare. In the case of Shakespeare the diversity amongst the several originals is strikingly evident, and thus a composite was needed to give a characteristic, individual, natural face. This suggested to Mr. W. C. Taylor the application of the same process to Washington's portraits. He has grouped the several portraits into three groups, owing to the differences of position of the portraits, and the accuracy of the work is well shown by the fact that the agreement amongst the resulting three composites is very close, while the originals show every shade of individual differences. These portraits were first published in the *Journal of the Franklin Institute*, and are given on a new and enlarged plate in the number of *Science* for December 11.

In pursuance of a resolution passed at the Medical Congress on Brain Diseases, held during the past summer at Antwerp, by which it was suggested that local conferences should be held to draw up trustworthy international tables of statistics on insanity, a Conference of Austro-Hungarian specialists will be held at Vienna on the 26th and 27th inst., with the object of revising and extending the nomenclature of mental disorders. Invitations to the Conference have been issued by four leading doctors of Vienna.

The work of spawning Salmonidæ at the establishment of the National Fish-Culture Association at Delaford Park has commenced, and it is expected that a large number of ova will be obtained. The establishment, which was opened in the early part of the present year, is now in excellent order, and all the fish that have been reared are doing well. It has been found necessary to increase the number of breeding-ponds in view of the extensive nature of the operations to be carried on next year.

The new aquarium for the Indian and Colonial fish at South Kensington is now in course of construction and will be on view at the next Exhibition. The tanks are to be erected at the back of the present aquarium, which will be maintained as heretofore, but as the fish to be exhibited require careful and special treatment no connection can exist between the two aquaria, which will be quite separate. It is to be hoped that the collection, when formed, will not be allowed to collapse at the termination of the forthcoming Exhibition, but that it will be maintained as a permanent institution, for an aquarium of foreign fish is much needed in London.

THE last issue of the *Izvestia* of the Russian Geographical Society contains a very interesting communication, by M. Yadrintseff, on the beginnings of settled life, being a contribution to the history of the rise of civilisation among the Ural Altayans. The paper is a *résumé* of an elaborate work on the subject which we hope soon to see published in the *Memoirs* of the West Siberian Geographical Society. M. Yadrintseff has had at his disposal very extensive materials, derived both from his own intimate acquaintance with the life of the native Siberians, and from a careful study of their history. Siberia is really one of the best fields for studying those intermediate phases of life which ultimately lead to the nomads becoming settled. Not only do the inhabitants of Siberia show us all possible stages in the transition from a nomadic life to that of settled agriculturists, but all these stages may also be studied under the varied aspects they assume when the modification goes on in different physical and geographical conditions, for example, in the forest regions, in the steppes, in the narrow valleys of the hilly tracts, and on the broad surfaces of the plains. It is easy to foresee what a valuable mass of information could be gathered in Siberia on this subject by an observer so well acquainted with his mother-country as M. Yadrintseff is; but it would be impossible to sum up in a few words the varied results to which the study has brought the author. The disappearance of entire civilisations like those of the Ural Altayans who immigrated into the plains of Siberia from the hilly tracts of the Altay, only add to the already great interest of the subject. We notice, moreover, the importance justly attached by the author to those intermediate phases which the nomad goes through when he abandons his former mode of life, and, by narrowing the region of his migrations, by staying at a permanent wintering place, and by merely migrating from a permanent summer dwelling to a winter dwelling, finally becomes a settled agriculturist; the relative facility with which this modification is undergone by the inhabitant of a forest region as compared with the difficulties met with by an inhabitant of the steppes; the similarity between many Siberian indigenes now passing through these intermediate phases of civilisation and the Germans at the time of Tacitus; and very many minor conclusions, all possessing great interest.

AMERICAN papers state that an aërolite or meteoric stone, which caused a loud detonation, heard throughout the greater part of Washington and Alleghany counties, Pa., on Saturday, the 3rd inst., fell upon the farm of Mr. Buckland, in Jefferson township, Washington county, near the West Virginia line. A mail carrier states that looking up he saw, moving high above him, a huge mass, which he described as resembling a great coal of fire as large as the largest barn he ever saw. There appeared to be attached to it an immense flame of a deep red colour, which tapered off into a darker tail. Instantly the noise which accompanied it ceased; the fire-like appearance, the flame, and the tail disappeared, and in their stead the stone assumed a whitish hue, which it retained until it passed out of sight. When the stone fell it broke into three pieces, but did not penetrate the earth to any great depth, as two-thirds of it remained above ground. It is grayish in colour, with a succession of red streaks, is irregular in form, and at least fifty feet in diameter.

A CORRESPONDENT of the *Times*, referring to Sir John Lubbock's discovery of much greater longevity of ants than has hitherto been believed, thinks that the same may be true with regard to the butterfly, although the common notion is that the butterfly's life is a short and merry one. The correspondent, who writes from Bournemouth, then relates the following incident:—"On August 15 last a fine peacock butterfly flew into our house through the garden door, and was caught and put under a large bell glass. On the following day another came in, and was also put under the glass. They were supplied daily with fresh flowers and a few drops of new honey, which they evidently much enjoyed. No. 1 died during a suddenly cold night, No. 2 lived until yesterday, December 14. Whenever the sun shone upon their cage, which was placed on a table near a large window of plate glass, they opened their beautiful wings and flew about vigorously, occasionally resting on a flower to thrust their trunks deeply into its corolla, or standing over and sucking up the drops of honey. The extraordinarily sensitive nervous system of these little beauties was indicated by the most rapid vibratile trembling of the wings directly the sunlight or the scent of fresh flowers reached them. When the sun was not out they usually remained perfectly still, with their wings closed, especially selecting to hang on the under side of a leaf. They showed great intelligence in distinguishing the freshly-gathered flowers and in deciding that honey was the right thing to eat, and I have seen one of them scramble with considerable difficulty across his cage through a tangle of leaves and stalks, determined to get to a particular leaf on which he wished to hang. After some unsuccessful attempts to reach it, he hooked it down with one foot, then held it with another, until he could get the rest of his legs upon it, having done which he appeared satisfied, shut up his wings, and hung himself upon it, topsy-turvy, to rest. If he failed to do what he wished with one leg, he immediately tried another, appearing to think that, having six at his disposal, it was foolish to waste much time on any one. But he only used his most anterior pair on very special occasions. How long each butterfly had lived before it was caught I do not know, but No. 2 lived in its glass cage 121 days."

THE amount of carbonic acid in the air has recently been measured by MM. Spring and Roland in a series of 266 determinations in the course of one year, the place being at Liége, in Belgium, having on one side a busy centre of the iron industry and on the other an agricultural district. The average obtained was 5·1258 parts by weight and 3·3526 parts by volume in 10,000 parts of air. This is considerably more than the air of Paris contains (4·83 and 3·168 respectively). Besides the plentiful carbonic acid from those iron-works, there is a large emission of the gas from the ground, which is rich in coal; indeed, cases of local heating often occur, with withering of the plants. To the relative abundance of carbonic acid the authors attribute the greater heat of Liége as compared with the surrounding regions, as the gas strongly absorbs heat-rays and limits radiation by night. A return of cold in May is thought to be due to the unfolding leaves diminishing the amount of CO_2, so that the nightly radiation is increased. The amount of CO_2 is considerably increased by a fall of snow (to 3·761 ten-thousandth parts by volume), except when the earth is already covered with snow. Cloud also gave an increase (3·571). The winter months gave a greater amount than the summer. The difference between day and night was but slight, nor had temperature nor rainfall a decided effect; but the rain in thunder-storms increased the amount. As to wind there were three maxima—viz. with north, north-west, and south-south-west winds, corresponding, apparently, to the directions of industrial centres. The CO_2 diminished in high winds and increased with a high barometer. These researches are the subject of a recent memoir to the Belgian Academy.

THE average heat-value of well-purified coal-gas at constant volume has been recently determined by M. Witz (*Ann. de Chim. et de Phys.*) as about 5200 calories per cubic metre at 0° and 760 mm. when the water formed is fully condensed. This value, got from a great variety of experiments with gas from different works, appears to make the generally-accepted figure of 6000 calories about 15 per cent. too high, and the calculation of gas motors is here concerned. The heat-value of the gas from one and the same works varied in the course of a year from 4719 to 5425 calories, which was more than the variation between different works. The influence of temperature and external pressure was not perceptible. The operations for purifying gas diminish the heat-effect, sometimes as much as 5 per cent. The gas of the last hour of distillation is (contrary to the usual view) less rich than that of the first hour. Dilution with oxygen lessens the heat-value; but in dilution with air, curiously, no such effect was observed; the heat of combustion was the same with six or with ten volumes of air.

IN his investigations of the changes of level of inland lakes (known as *seiches*), Prof. Forel has arrived at the simple formula $t = l / \sqrt{gh}$ for those movements, in which t expresses the time, in seconds, of a half oscillation of a uninodal *seiche*, l, the length, and h, the mean depth of the cross-section of the lake in which the variation is observed. This formula holds good for the lakes of Neuchatel, Brienz, Thun, Wallenstadt, and Geneva. An interesting confirmation of it is found by M. Forel in observations made by Mr. Russel with a limnograph on Lake George in New South Wales. This instrument had recorded 33 very regular *seiches* on the lake this year, and the duration of a whole oscillation proved to be 131 minutes. Now the length of the lake being 28,962 metres, the above formula gives, for the mean depth, 5·536 metres, or 18·1 feet. Mr. Russel states that the mean depth is between 15 and 20 feet.

THE prevailing direction of the winds on the shores of the Black Sea and the Sea of Azov has been recently studied in great detail, and in connection with the recent progress of meteorology with regard to wind generally, by M. Spindler, who has published his work, with maps, in the Russian *Maritime Review* (*Marskay Sbornik*). Four maps show the prevailing direction of the wind at 7 a.m. and at 1 p.m. during the four seasons of the year. During the winter a notable difference between the prevailing direction at these two hours of the day is seen only on the eastern shore; while in the spring and summer nearly everywhere on the Russian coast of the Black Sea these two directions differ by 90°, and at some places they are quite opposite to one another, thus showing that the predominating influence of the currents of air depend upon the different heating of land and sea.

IT is reported from Kara-hissar, in Asia Minor, that an earthquake shook that neighbourhood on Tuesday, December 2. In the hamlet of Kemin the earth opened for a length of about 40 feet, and from 3 to 5 feet wide.

THE last earthquake shock in Algeria was felt at Blidah on December 13, at 5 a.m. Subterranean noises were heard. The first shock, in Hussein Dey, near Algiers, was felt on December 3. at 8h. 23m. a.m. This has been proved by the stopping of a clock in a distillery.

HOW great are still the numbers of Carnivora in Finland may be seen from the following figures, given in the last issue of the "Statistical Yearbook" for Finland. In 1882 not less than 85 bears, 128 wolves, 407 lynxes, 4005 foxes, 76 gluttons, 240 river otters, 148 martens, 1583 ermines, and 3947 carnivorous birds were killed, for which an aggregate of 1646*l*. was paid in premiums by the Government. The ravages occasioned by Carnivora the same year were immense: they are estimated at 274 horses, 846 horned cattle, 5246 sheep, 168 pigs, 119 goats, 1681 reindeer, and 2366 domestic fowls. The greatest number of bears were killed in Viborg and Uleåborg (respectively 33 and 30), while most wolves were killed in the more densely-peopled Government of Tavastehuus.

AT the meeting of the Royal Physical Society of Edinburgh, held December 16, the following office-bearers were elected, viz.—President: Prof. William Turner, F.R.SS.L. and E., Edinburgh University; Vice-Presidents: John A. Harvie-Brown, F.R.S.E., Rev. John Duns, D.D., Prof. J. Cossar Ewart, F.R.S.E.; Secretary: Robert Gray, V.P.R.S.E.; Assistant-Secretary: John Gibson; Treasurer: Charles Prentice, F.R.S.E.; Librarian: William Evans Hoyle, F.R.S.E.; Council: John Hunter, F.C.S., Robert Kidston, F.G.S., A. B. Herbert, Prof. James Geikie, F.R.S., G. Sims Woodhead, F.R.C.P.Ed., Hugh Miller, F.G.S., Arthur W. Hare, M.B., R. Milne-Murray, M.R.C.P.E., H. Moubray Cadell, B.Sc., R. H. Traquair, F.R.S., R. Sydney Marsden, D.Sc., F.R.S.E., Benjamin N. Peach, F.G.S., F.R.S.E.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by the Rev. Spencer Fellows; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. J. Robson; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Mrs. Sturt Cavell; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. T. E. Gunn; three Wild Ducks (*Anas boschas*), British, presented by Mr. C. T. McNiven; a Lapwing (*Vanellus vulgaris*), British, purchased.

OUR ASTRONOMICAL COLUMN

TOTAL SOLAR ECLIPSE, 1886 AUGUST 28–29.—The eclipse will be total throughout the Island of Grenada. The *Greenwich* mean times of beginning and ending of totality for any point in the island may be found from the formulæ:—

$$\cos w = -4{\cdot}99267 - [1{\cdot}77822] \sin l + [1{\cdot}26284] \cos l \cos (\lambda + 48^\circ\ 13'{\cdot}5$$
$$t = 1\text{h. } 12\text{m. } 41{\cdot}7\text{s.} \mp [2{\cdot}04698] \sin w - [3{\cdot}24330] \sin l$$
$$- [3{\cdot}84970] \cos l \cos (\lambda + 82^\circ\ 53'{\cdot}0),$$

where l is the *geocentric* latitude of the place, λ its longitude from Greenwich, taken *negatively*, and the quantities in square brackets are logarithms; upper sign for beginning, lower for ending.

For long. 4h. 6m. 20s. W., lat. 11° 59'·5 N. near the *southern* extremity of the island, totality begins at 19h. 11m. 0s. local mean time, and continues 3m. 42s. ☉'s altitude 20°.

In long. 4h. 6m. 40s. W., lat. 12° 15'·0 N. near the *northern* extremity of the island, totality begins at 19h. 10m. 37s. local mean time, and continues 3m. 37s.

At Carriacou I. (Grenadines)—

Totality commences at 19h. 11m. 45s. local M.T.
Duration ... ... 3m. 21s.
Sun's altitude ... ... 20°

FABRY'S COMET.—Dr. H. Oppenheim continues his ephemeris of this comet in the *Dun Echt Circular*, No. 102, as follows:—

Ephemeris for Berlin Midnight

1885	App. R.A. h. m. s.	App. Decl. ° '	Log. Δ	Brightness
Dec. 28 ...	23 48 29 ...	+20 52·6 ...	0·0849 ...	1·6
29 ...	47 14 ...	54·8		
30 ...	46 2 ...	57·3		
31 ...	44 52 ...	21 0·0		
32 ...	43 45 ...	3·0 ...	0·0850 ...	1·8

β CYGNI OR 6 CYGNI?—M. Flammarion in the December number of *L'Astronomie* falls into a curious confusion with regard to these stars. Dr. Ball had found the parallax of B.A.C. 6579 (B) to be $+0''{\cdot}482 \pm 0''{\cdot}054$, and following Bode's numbers called the star 6(B) Cygni. Unfortunately, however, M. Flammarion supposed Dr. Ball referred to Flamsteed's 6 Cygni, which is β Cygni, and based an article on the supposed determination of its parallax. The mistake was a very easy one to make, but at least the Dunsink observations are not to blame, for Dr. Ball gives not only the place of the star he observed but its number in three catalogues—Groombridge, Struve's *Mensuræ*, and the *Durchmusterung.*

BARNARD'S COMET.—Dr. H. Oppenheim (*Astr. Nachr.*, No. 2697) has computed the following elements and ephemeris for this comet:—

Perihelion Passage = 1886 May 14·1430 Berlin M.T.

$$\left.\begin{aligned} \omega &= 116^\circ\ 31'\ 57'' \\ \Omega &= 66\ 22\ 12 \\ i &= 94\ 8\ 7 \end{aligned}\right\}\text{Mean Eq. } 1885{\cdot}0$$

$$\log. q = 9{\cdot}74184$$

Error of the middle observation:—

$$\delta\lambda = +4'' \qquad \delta\beta = -3''.$$

The elements resemble those of Comet 1785 II.

Ephemeris for Berlin Midnight

1885	App. R.A. h. m. s.	App. Decl. ° ′	Log. Δ	Brightness
Dec. 24 ...	3 30 5	... +7 2·6	... 0·2372	... 1·3
26 ...	25 12	... 19·8		
28 ...	20 23	... 37·5	... 0·2358	... 1·4
30 ...	15 39	... 55·8		
32 ...	11 1	... +8 14·6	... 0·2359	... 1·5

The brightness on December 5 is taken as unity.

THE PULKOWA OBSERVATORY.—From his Report, presented May 25, 1885, it appears that M. O. Struve was chiefly occupied, during the year to which the Report refers, with work connected with the erection of the great 30-inch refractor. Various unexpected delays had occurred, in connection chiefly with the construction of the dome, but, at the time of writing his Report, M. Struve states that regular observations could be commenced immediately. He expresses himself as greatly pleased with the mounting of the instrument, which has been designed and constructed by the Repsolds. At present the dome is moved by hand, but it is hoped that this may eventually be done by electricity, and that motive power will thus be obtained sufficient to overcome the hindrance to the rotation of the dome caused by snow and frost. It is proposed to use the great refractor for observing such double-stars as are beyond the reach of the 15-inch equatorial, and to undertake observations of interesting nebulæ, as well as spectroscopic researches in cases where the great optical power of the instrument will be of special importance. We learn from *Science* that M. Struve has written to Messrs. Alvan Clark and Sons, acknowledging the excellent performance of the object-glass furnished by them, and announcing that the Emperor of Russia had conferred on them the Honorary Gold Medal of the Empire.

Notwithstanding the additional cares and labours thus imposed on the staff of the Pulkowa Observatory, further increased by M. O. Struve's regrettable illness, the usual work in the various departments has been kept up with vigour, and it is evident that the famous Russian institution, under its present superintendent, will continue to maintain its great reputation.

SUSPECTED "NEW" STAR.—It is announced in the *Dun Echt Circular*, No. 104, that Mr. Gore, observing with a binocular on the evening of December 13, found a reddish star of 6th mag., and about 20′ following χ' Orionis. This object is not given by Harding, Lalande, Heis, Birmingham, or the Bonn maps. On December 16 Copeland and Becker, observing at Dun Echt, found it of the 6½ mag., and of an orange-red colour. It has a very beautiful banded spectrum of the third type, seven dark bands being readily distinguished with the prism. The bright intervals seem full of bright lines, especially in the green and blue. The mean place for 1885 is R.A. 5h. 48m. 59s.; Decl. + 20° 9′·4.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1885 *DECEMBER* 27—1886 *JANUARY* 2

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 27

Sun rises, 8h. 8m.; souths, 12h. 1m. 27·7s.; sets, 15h. 55m.; decl. on meridian, 23° 19′ S.: Sidereal Time at Sunset, 22h. 20m.

Moon (at Last Quarter on Dec. 28) rises, 22h. 18m.*; souths, 4h. 56m.; sets, 11h. 23m.; decl. on meridian, 4° 19′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridia ° ′
Mercury ...	6 36 ...	10 51 ..	15 6 ...	19 57 S.
Venus ...	10 28 ...	15 13 ...	19 58 ...	15 5 S.
Mars ...	22 30* ...	5 6 ...	11 42 ...	6 19 N.
Jupiter ...	23 57* ...	5 57 ...	11 57 ...	0 50 S.
Saturn ...	15 44 ...	23 54 ...	8 4* ...	22 31 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Occultations of Stars by the Moon

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
27 ...	τ Leonis ...	... 5 ...	5 48 ...	6 47	... 110 232
29 ...	θ Virginis...	... 4½ ...	4 5 ...	5 15	... 60 211
Jan.					
1 ...	η Libræ ...	... 6 ...	5 8 ...	6 15	... 58 210

Dec.	h.	
27 ...	9 ...	Mars in conjunction with and 2° 48′ north of the Moon.
28 ...	9 ...	Jupiter in conjunction with and 0° 5′ south of the Moon.
31 ...	5 ...	Sun at least distance from the Earth.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2 ...	81 16 N. ...	Dec. 29,	1 24	*m*
Algol	3 0·8 ...	40 31 N. ...	,, 27,	21 29	*m*
			,, 30,	18 18	*m*
ζ Geminorum ...	6 57·4 ...	20 44 N. ...	Jan. 2,	22	*M*
S Canis Minoris ...	7 26·5 ...	8 34 N. ...	Dec. 27,		*M*
S Cancri	8 37·4 ..	19 27 N. ...	,, 31,	4 8	*m*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 29,	18 39	*m*
			Jan. 1,	2 30	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	Dec. 30,	5 59	*m*
R Coronæ	15 43·9 ...	28 30 N. ...	,, 31,		*M*
δ Cephei	22 24·9 ...	57 50 N. ...	Jan. 1,	6	*m*
			,, 2,	22	*M*

M signifies maximum; *m* minimum.

Meteor Showers

The principal periodic shower at this time is that of the *Quadrantids*, R.A. 225°–232°, Decl. 55°–60° N., seen on January 2 and 3. As the radiant-point rises after midnight, the shower must be looked for during the morning hours. A shower with radiant near Aldebaran may be looked for during this week and throughout January.

Stars with Remarkable Spectra

Mira Ceti, R.A. 2h. 13m. 36s., Decl. 3° 29′·6 S., should be examined with the spectroscope on every favourable opportunity now that it is approaching its maximum. It is a fine example of Secchi's third type.

Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Mag.	Type of spectrum
γ Cassiopeiæ ...	0 50 6 ...	60 7·0 N. ...	2·2 ...	Bright lines
Mira Ceti	2 13 36 ...	3 29·6 S. ...	Var. ...	III.
ρ Arietis	2 49 24 ...	17 52·1 N. ...	6·0 ...	III.
α Ceti...	2 51 19 ...	3 38·5 N. ...	2·5 ...	III.
ρ Persei	2 57 52 ...	38 24·0 N. ..	Var. ...	III.
D.M. + 57°·702 ...	3 2 38 ...	57 28·2 N. ...	7·9 ...	IV.
51 Schj.	4 59 30 ...	1 1·2 N. ...	6·0 ...	IV.
20 Leporis... ...	5 6 3 ...	11 59·4 S. ...	6·0 ...	III.
α Orionis	5 49 0 ...	7 23·1 N. ...	Var. ...	III.
μ Geminorum ...	6 16 3 ...	22 33·6 N. ...	3·0 ...	III.
78 Schj.	6 28 42 ...	38 31·0 N. ...	6·3 ...	IV.
51 Geminorum ...	7 6 49 ...	16 18·4 N. ...	5·5 ...	III.

GEOGRAPHICAL NOTES

Two papers in the December number of the *Proceedings* of the Royal Geographical Society are of unusual interest. The first is Mr. F. Simons's account of his exploration of the Goajira peninsula of the United States of Colombia; the second, a series of letters, hitherto unpublished in English, from Colonel Prjevalsky, translated by Mr. Delmar Morgan. Mr.

Simons first describes the topography of the little-visited peninsula in some detail, and then gives an account of the tribe of Indians inhabiting it, which is of exceeding interest, so remarkable are many of their customs. Their system of compensation—consisting of tear and blood-money, or fines for tears or blood supposed to be shed—is one of the most extraordinary ever found amongst a primitive people, extending not only to injuries, wilful or accidental, done to one man by another, but to accidents happening to a man himself. Every man is a hostage for every one of his clan, and is liable to be called upon to pay various fines for the acts of another; if a man borrows an animal of another and is thrown off, the lender has to pay, first, the relatives of the mother, then the relatives of the father, and, lastly, the friends of the borrower. If a man injures himself he is forced to pay his mother's relations for his own blood which has been spilt, his father's for the tears which they are presumed to have shed, and his friends for the sorrow the accident has caused them,—and all this if he has only cut his finger with his knife. Many other curious customs are also recorded. Colonel Prjevalsky's letters describe certain districts around Lob-Nor, and the route to Cherchen and Kiria. The work of the Admiralty Surveys for 1884 is detailed from the Hydrographer's report. Sir Frederic Goldsmid writes on the geographical nomenclature of places between Merv and Herat, and Admiral Irminger, of the Danish Navy, explains, in a letter to the secretary, the so-called subsidence of one of the Faroe Islands, which turns out not to have been a "subsidence" at all.

M. POTANIN has again written to the Geographical Society, from Si-nin, under date of April 29. The expedition was continuing its work without the least hindrance, MM. Potanin, Stassy, and Berezovsky exploring the region in all directions, after having wintered in three different towns; the astronomical determinations were also made, and the population, far from hindering the surveys, assisted them. A Tangut, in the service of M. Potanin, is a valuable aid in making collections of insects. MM. Potanin and Skassi left San-chuan on April 15, taking a northerly direction to reach the Si-nin River (called Nimbimuren in its lower course). Its valley is inclosed between high walls of loess, and at three different points it is narrowed by crags of gneiss, where some gold is dug. In the Lau-va-sya gorge the limestone crags are covered with numerous and beautiful *marmites de géant*, one of which has a diameter of 160 centimetres. Above this gorge the valley reaches a width of more than two miles, and two towns, Lau-va-sya and Nimbi, are situated there. They are peopled with Mongols, many of whom are Mussulmans; the villages are peopled with Chinese. Si-nin was reached on April 24, and M. Potanin proposed to leave it soon for Min-cheu, *via* Gui-Dui, so as to connect his surveys with those of M. Prjevalsky.

THE German Emperor has ordained that the harbour discovered on the north-east coast of Kaiser Wilhelm's Land, north-west of Port Constantine, shall henceforth be known as "Friedrich Wilhelm's Hafen," and the bay near it "Prince Heinrich's Hafen"; the large navigable river discovered east of Cape de la Torre as the "Kaiserin Augusta Fluss," while Beaupré, situated in the middle of the peninsula will now be called "Varzin." "Neu Mecklenburg" will be substituted for New Ireland, "Neu Lauenburg" for the Duke of York group, and "Neu Pommern" for New Britain, the largest island of the Bismarck Archipelago.

THE voyage of the *Vega* along the north coast of Europe and Asia seems likely to bring about another result, namely, the connection of the Petchora with the Obi by a route presenting fewer dangers than the navigation of the Kara Sea. Thanks to the continuous efforts of MM. Sidoroff and Sibiryakoff, the exploration of the Northern Urals, with a view to discover the best routes for connecting the great river of North-East Russia with the chief artery of Siberia, is being busily prosecuted. It appears now, from a communication by M. Nosiloff to the Russian Geographical Society (*Izvestia*, iv. 1885), that there are in the Northern Urals passes which would permit of establishing an easy link between the two basins. The best of them seems to be the Schokuriinsk Pass, the same that Prince Kurbsky availed himself of in 1449 to reach the Obi. A portage, only 98 miles long, leads from Kuya—a village on the Petchora, within easy reach of steamboats—to the Sygva River, a tributary of the Sosva, which appears to be navigable for boats up to a point distant only 35 miles from the pass over the Ural Mountains. The Sygva has a depth of from 4 to 7 feet, and a width of 150 to 350 yards; while the Sosva, 6 to 18 feet deep, forms an excellent channel for even larger vessels. As to the portage itself, its highest point reaches only 1450 feet above the sea, and 1150 feet above the Sygva; and a railway less than 100 miles long would avoid all those difficulties which are now presented by the navigation of the Kara Sea and the ice-bound Gulf of Obi. Another pass, Voikarsky, is at almost the same distance, and its highest point rises about 1650 feet above the sea. The existence of these deeply-indented valleys, and the general configuration of the region, together with the direction of the rivers, once more raises the question, whether the Northern Urals, instead of being *one* winding mountain-chain, are not rather a complex of several smaller chains having a north-easterly direction, and arranged in *échelons* from south to north. It would be most desirable to have a thorough orographical and geological exploration undertaken in connection with the above work, in order to settle one of the most important questions as to the orography of the northern part of the great Russian plain.

WE notice in the last issue of the *Izvestia* of the Russian Geographical Society (1885, iv.) the following information communicated by Gen. Meyer with regard to the Transcaspian region. The great ranges of mountains which bear the names of Great and Little Balkhans, Kuren-dagh, and Kopet-dagh, and are continued on the Persian frontier under the names of Aselma, Deireghez, Kelat, and so on, diminish in height towards the east, until they almost entirely disappear about Sarakhs. The chief range reaches, however, 6000 to 7000 feet, with separate peaks 8000 feet high, and the upper parts of its northern slope are covered with snow nearly all the year round. Notwithstanding this, the streams which flow from these mountains into the steppes are remarkably poor; the slates, of which the slopes of the mountains consist, giving the water a free passage into the soil. The ancient inhabitants knew how to utilise this structure of the soil by making their *kerizes*, or wells, connected together by underground galleries, which, after being dug thus for a mile or two, yielded water for irrigation. These wells are now unfortunately mostly in a bad state, and few of them are of any use. The much-talked-of dams on the Murghab and Heri-rud would not be of great use, as the high water in both rivers comes in the spring, and not in the summer when the fields are most in need of irrigation. The characteristics of the ground are strikingly uniform, a terrace with a soil of dry clay, intersected by small ravines, in all cases spreading at the foot of the mountains. The climate is very dry, but fevers are common, probably in consequence of the very rapid variations of temperature from a hot day to a cold night. At Askabad the yearly average temperature is 24°·8 C., the extremes being 31°·5 and − 8°·1. Up to a height of 4000 feet the mountains are covered with a steppe flora. Higher up they are mostly quite devoid of vegetation. The *artcha*, reaching sometimes twenty-five feet, but never growing in forests, is excellent as fuel, but cannot be employed for building. A few willows, poplars, and rushes are sometimes met with along the streams. In the spring the plains are all covered with herbaceous vegetation, which is, however, unfit for pasture. Grazing-grounds are met with only on sandy ground about Akhal. Further east, towards Merv, there are no pasture-grounds, but trees are more numerous. When watered the soil gives good crops: wheat, barley, the Khiva millet, lucerne; cotton and silkworm trees grow well on watered fields, as also poplars, willows, plane-trees, and various kinds of brushwood.

THE following information as to the population of the Transcaspian region, communicated to the last issue of the *Russische Revue* (1885, iv.), by M. Seidlitz, may complete the above. The aggregate population of the region is estimated at from 214,000 to 260,000 inhabitants, including Merv—that is, much below previous estimates. The whole region being divided into the districts of Akhal-tekke, Krasnovodsk, Manghishlak, Merv, and Tejen, it appears that the population of the three former districts numbers about 93,000, who live on agriculture in Akhal-tekke and on cattle-breeding in Krasnovodsk and Manghishlak. The agriculture of Akhal-tekke is considerable, the crops of 1883 having yielded no less than 190,000 quarters of wheat, barley, and *Sorghum cernuum*. The cattle in the three districts are estimated at no less than 44,000 horses, 76,000 camels, and more than 600,000 sheep, to which nearly 130,000 horses, 193,000 camels, and one million and a half of sheep must be added for Merv and Tejen. The culture of cotton and of the silkworm in Akhal-tekke is also worthy of notice. The population of Akhal-tekke consists of Tekke-Turcomans (8400 *kibitkas*, about 42,000 souls), with some 1160 Persians and Tartars, 930 Armenians, and 340 Russians, without families. Askabad, the chief town of this district, has already an important trade. The inhabitants of the Krasnovodsk and Manghishlak districts, on the contrary, are nearly all nomads, and their chief towns, Krasnovodsk and Alexandrovsk, are miserable hamlets with less than 400 inhabitants each. The oasis of Merv, with its 32,000 *kibitkas*, is well peopled. The *bazaars* of the chief town are very animated, 8000 to 10,000 people gathering there twice a week. Since 1785, when the Sultan-bend dam on the Murghab was destroyed by the Ameer Murad Khan, the area of the oasis has much diminished, and it occupies now only a length of 160 miles, and a width of some 13 miles. The town Bairam-kalæ was abandoned for want of water. The Tekke Turcomans, who have inhabited the oasis since 1857, when they drove away the Saryks, are divided into two stems, the Okhtamyshs and the Tokhtamyshs. The richer of them live in felt tents, while the poorer ones make huts of clay of the same shape as the felt tents. These settlements and villages are not permanent, and may be changed at the first signal of alarm. In fact the population is too numerous for the watered area. As to the fertile oasis of Tejen, on the Heri-rud, it was formerly visited only in the summer. It has now some 7500 Tekke inhabitants, who have immigrated from Merv, Akhal, and Atek.

MR. SHIPLEY, the American Consul at Auckland, New Zealand, reports to the State Department at Washington, the following facts about a new volcano in the Pacific Ocean :—"At daylight on October 13 we observed dense volumes of steam and smoke clouds ascending. We sailed sufficiently near to see that it was a submarine volcanic eruption. Considering that it was not prudent to approach any nearer that night, we lay to until morning. We then approached to about a distance of two miles. I have not words to express my wonder and surprise at its changing splendour. Eruptions take place every one or two minutes, changing in appearance every second, like a dissolving view. I can only say that it was one of the most awfully grand sights I ever witnessed on the high seas. As near as I was able to calculate the position of the volcano, it is about fourteen miles from the island of Honga Tonga. As to the size of the island thrown up, I am unable to state it correctly, there being so much steam and cloud hanging over it; but I judge it to be at least two or three miles long, and 60 feet high, in lat. 20° 21′ S., long. 175° 28′ W."

THE PARIS ACADEMY OF SCIENCES

THE yearly meeting of the Paris Academy of Sciences took place in the large hall of the Institut on December 2. Rear-Admiral Julien de la Gravière was in the chair. He read a short paper summarising the *éloges* of eight members who died during the past twelve months. This number is unusually large in a body of sixty-six.

M. Bertrand delivered two addresses on M. Lagourneria, a geometer, and M. Combes, an engineer, who died some years ago, after having enjoyed the academical honours during many years.

The number of prizes delivered by the Academy is increasing yearly, not less than thirty-three being offered for competition in 1886. The total of the sums to be awarded is more than 3000*l.*, exclusive of some of which the value is to be determined according to the merits of competitors, and the Bréant Prize for a cure for cholera. Dr. Ferran was not even mentioned in the verdict, and the interest of the 4000*l.* was given to several writers on the etiology of cholera.

Some of the prizes for 1885 were not awarded, for want of competition, although, except a very few, they are open to every nation, and memoirs can be written in any language as well as in French. A large number of prizes were not delivered for want of merit in the contributions sent. Some of them were awarded to scientific writers who have published volumes on topics connected with the subject-matters. Of this last class we may mention, *inter alia*, "Memoire sur la Marche et l'Extension du Choléra Asiatique des Indes Orientales," &c., by Dr. Mahé, representing France at Constantinople; "Contributions à l'Etude de la Fièvre Typhoïde," by Dr. Pietro Santo; "Statistique de l'Industrie minérale et des Appareils à Vapeur en France et en Algérie," by M. Keller; "Contributions à l'Etude statistique du Suicide en France," by Dr. Jules Socquet; "Histoire de l'ancienne Académie de Marine de Brest," by M. Donneaud du Plan, Librarian of the Navy at Dieppe.

Amongst the most important prizes awarded we notice the following :—

M. Amsler Laffon, of Shaffhouse, for his instrument for polar planimetry, as presented by Mr. Scott Russell to the Institution of Naval Architects in 1880 (Monthyon Medallist for Mechanical Arts).

M. Colladon, of Geneva, for the application of compressed air as a motive power in tunnelling Mont Cenis (Fourneyron Medallist).

M. Thollon, for mapping the solar spectrum in the Bischoffsheim Observatory, Nice (Lalande).

Dr. Spörer, of the Potsdam Astro-Physical Observatory, for his studies on solar spots (Voltz).

Dr. Edlund, member of the Academy of Sciences of Stockholm, for his memoir on the origin of electrical tension of the atmosphere. He considers this tension to be produced by the rotation of the earth, which is a magnet. The soil being made negative, the atmosphere becomes positive by induction. The difference of tension resulting from his calculations is 223 volts per kilometre altitude. No less than twelve memoirs were sent —five in French, four in German, and three in English (Boydron Prize). The memoir of Dr. Edlund had been already printed and published.

M. Gernez, for his discoveries in rapid solidification of supersaturated liquids.

M. Halphen, a major in the French Artillery, took the Petit d'Ormay Prize for the *ensemble* of his mathematical work and principally the solution of the following problem :—Trouver les équations différentielles qui se reproduisent par une substitution linéaire.

The Monthyon Prize for discoveries in connection with unhealthy arts has been given to M. Chamberland, chief assistant of M. Pasteur, who invented a filter in chinaware which stops even microbes.

The Government Prize was given to M. Joannes Chatin for his study of the sensation organs of invertebrate animals.

The Cuvier Medallist for this year is Prof. Van Beneden, of the Louvain University, for half a century of work in physiology.

THE NEW ZEALAND INSTITUTE

THE volume of *Transactions* of the New Zealand Institute for 1884 was issued to the members in May of the present year. It is edited by Dr. Hector, and contains fifty-five memoirs, which, read before the various affiliated societies, have been deemed worthy, by the Governors of the Institute, of publication. While the papers on biological subjects occupy three-fourths of the space devoted to the transactions, those on geology are but few in number. Among the more important of the zoological memoirs may be mentioned the following :—"Descriptions of New Zealand Micro-Lepidoptera," by E. Meyrick (pp. 68–149). In continuation of his previous memoirs we have here full details and an analysis of the following families :— Scopariadæ; while no species of this family is common to New Zealand and Australia, the author has included in his memoir descriptions of the known Australian species of the genera Scoparia, Tetraprosopus and Xeroscopa. Fifty-eight species of the first and sixteen species of the last genus are described. Pyralidæ: Hydrocampidæ; these families are each represented by a single species, neither of which is, in a strict sense, indigenous, *Asopia farinalis* being introduced from Europe. The representative of the latter family, *Hygraula nitens* (Butl.), being regarded as a recent migrant from south-east Australia. Pterophoridæ; eleven species are described: one is closely allied to a European form, one is Australian; the other nine are all endemic. In a supplement a number of additions to the previously-published list of species of Crambidæ and Tortricidæ are described. "Further Notes on Coccidæ," by W. M. Maskell. The author comments on our notice this time last year of the roughness of the plates in Vol. XVI. While we agree with him that all biologists are not artists, yet we venture to think that it is not too much to expect that there should be one artist at Wellington who could execute plates in a style worthy not only of the New Zealand Institute, but in keeping with the excellent typography of the volume. Thus, the very "lettering" of the plates in the present volume is not only bad, but misleading, Vol. XIV. being misprinted for Vol. XVII., and Plate

8 for Plate 7. We notice, however, an improvement in the lithography. In his notes Mr. Maskell describes several new species, and advances our knowledge of the New Zealand fauna very considerably. In a paper on the spiders of New Zealand, Mr. A. T. Urquhart describes and figures a great many new species, chiefly from the neighbourhood of Auckland. Prof. Jeffrey Parker gives notes on the skeleton and baleen of a Fin Whale (*Balænoptera musculus*), and Mr. S. Mieson gives some interesting details about a plague of rats in Nelson.

Among the botanical memoirs may be noted those of Mr. T. Kirk, on the flora of Stewart Island. Prefaced by a short sketch of the island, and the facts previously known as to its natural history, Mr. Kirk gives the results of his investigations of its flora made during two visits in January, 1882, and in January, 1884. So far as at present known the flora of the island comprises about 380 species of Phænogams, and nearly 70 species of Pteridophytes. The area of the island is estimated at 640 square miles. Attention was at once attracted by the blaze of crimson presented by the flowers of *Metrosideros lucida*, often flecked by the beautiful pale racemes of *Weinmannia racemosa*. *Veronica salicifolia* occurred by the side of water-courses, but was far from common. The soil was often carpeted with a compact growth of the charming liliaceous plant *Callixene parviflora*, with its elegant drooping flowers. The terrestrial orchids formed a marked feature in some parts of the forest. *Coryanthes oblonga* and *C. rivularis* produced their attractive flowers literally by thousands. Arborescent ferns were abundant, the most abundant being *Dicksonia squarrosa* and *Hemitelea smithii*. The crest of Mount Anglem, the highest peak of the island, was ascended. The weather, unfortunately, was unfavourable, the driving snow obscuring the prospect. A splendid Alpine flora was discovered. *Dracophyllum muscoides* formed a compact dark green sward gemmed with white flowers; several species of Coprosma, *Ranunculus lyalii*, the beautiful *Ourisia sessiliflora*, also *O. cæspitosa*.

On exposed portions of the coast on both sides of the island *Olearia angustifolia* was found; it is one of the grandest of flowering plants. Varying in size from shrubs of about 6 feet high, to a tree of 20 feet, the snowy ray florets, with the dark purple of those of the disk of the innumerable flower heads, set off by the dark, deep, glossy green foliage, form a never-tiring source of attraction, while the aromatic odour exhaled is of a grateful type. *O. trailii*, also another splendid species, but sparingly occurred. A list of the ferns and fern allies is given. *Todea superba* grows luxuriantly; one specimen was examined which had a stout stem some 18 feet high, from which arose a dense crown of nearly erect fronds, with drooping tips; some of these were several years old and were between four and five feet in length, of a deep blackish green. Mosses and large frondose Hepaticæ also abounded.

Mr. Cheeseman, Mr. Colenso, and Mr. Petrie, continue their descriptions of species new to science and to New Zealand.

In the section devoted to geology Capt. F. W. Hutton describes a large number of new Tertiary shells; Dr. J. von Haast has notes on the geological structure of the Southern Alps of New Zealand, in which he criticises Dr. Hector's recently-published map of this district; and Dr. Hector has a note on the geological structure of the Canterbury Mountains, in which he very temperately justifies changes in his views of geological periods as based on the progress of his knowledge of facts. Mr. James Parks's account of the ascent of Mount Franklin will be read with interest; though occupying a central position in the province of Nelson, it does not seem to have been before ascended. The Waiau Gorge is described as one of the most wonderful in New Zealand. On both sides the mountains frequently rise by a succession of steep, rugged precipices to a height of 3500 feet over the river. About 6050 feet high a small area of glacier ice was found, probably all that now remains of the great Waiau Glacier. Small patches of red snow were found; at 6500 feet in height permanent snow-fields were met with, and the top of the range, described as a mere razor-back, only a few feet wide, and composed of loose, angular, and slab-like rocks was found to be 7500 feet high. The highest peak, by aneroid measurement, was 350 feet higher. A list of the Alpine plants collected on the occasion, and determined by Mr. J. Buchanan, is appended.

It will be judged from this short notice that this volume, edited by Dr. Hector, is one coming in no way short of its predecessors and that it reflects credit on the scientific workers of New Zealand.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—A Fellowship will be filled up in Lincoln College in January next.

The Examination will be in the subjects of Animal Physiology and Animal Morphology; and candidates are invited to send in any treatises or theses that they may have written or published in special branches of one or both of these subjects.

Candidates should communicate at once with the Rector, who will furnish them with full information as to the conditions and tenure of the Fellowship.

CAMBRIDGE.—Another development from Prof. Stuart's School of Engineering is probable. The Special Board for Physics and Chemistry, considering the number of students of engineering warrants such a step, propose for their benefit an Honours Examination, to be connected with the Natural Sciences Tripos. Certain branches of Mathematics, useful alike for students of Engineering, Physics, and Chemistry, are to be introduced into an examination alternative with the first part of the Natural Sciences Tripos. Papers should be included on Principles of Measurement, Theory of Structures, Properties of Matter, Principles of Mechanism, and other branches of Physics and Chemistry, and there should be practical work in Engineering, as well as in Physics and Chemistry, each candidate being required to pass the practical examination in at least one of these three subjects. A student passing this examination with credit in his third year should be entitled to a degree in honours.

A second higher Examination is proposed, to be concurrent with the second part of the Natural Sciences Tripos, in the same subjects as above-mentioned, and the examiners should be at liberty to set questions involving the Mathematics of the first Examination, and in those parts of Mineralogy which belong to Physics and Chemistry. Other conditions are similar to those of the Natural Sciences Tripos. The Special Board for Mathematics has expressed its general approval of the scheme.

At St. John's College E. H. Hankin and F. S. Locke, both of St. Bartholomew's Hospital Medical School, have been elected to Exhibitions of 50*l*. a year in Natural Science. In Mathematics, F. M. Monro, King William's College, has been elected to a Foundation Scholarship of 80*l*. a year; A. G. Cooke, City of London School, to a Minor Scholarship of 75*l*. a year; A. Kahn, Middle Class School, Cowper Street, E.C., and J. A. Lawrenson, Liverpool Institute, to Minor Scholarships of 50*l*. a year; W. H. Box, University College, Aberystwith, and S. Humphries, Middle Class School, Cowper Street, E.C., to Exhibitions of 40*l*. a year for three years.

SCIENTIFIC SERIALS

The Journal of Anatomy and Physiology for October (vol. xx. part 1) contains:—On the anatomy of the muscles, ligaments, and fascia of the orbit, by C. B. Lockwood (plate 1).—Two cases of an abnormal coronary artery of the heart arising from the pulmonary artery, by Dr. H. St. John Brooks (plate 2).—On a second bursa connected with the insertion of the biceps, &c., by A. Ward Collins.—Abnormalities of the lobes of the human lung, by A. E. Maylard.—On the nature of ligaments, part 4, by J. Bland Sutton (plate 3).—Vital relations of micro-organisms to tissue elements, by Drs. G. S. Woodhead and A. W. Hare.—The blood-forming organs and blood-formation: an experimental research, part ii., by Dr. J. Lockhart Gibson.—The relationship of urea-formation to bile-secretion: an experimental research, by Dr. Noel-Paton.—The index of the pelvic brim as a basis of classification; and on the anatomy of Sowerby's whale, by Prof. W. Turner (plate 4).

The Quarterly Journal of Microscopical Science for October contains:—On the chromatology of the blood of some invertebrates, by Dr. C. A. MacMunn (plates 33 and 34). Among other pigments referred to, the colouring-matter of the perivisceral fluid of *Strongylocentrotus lividus*, named echinochrome, is described in detail.—On the cephalic appendages of the gymnosomatous Pteropoda, and especially of Clione, by Dr. Paul Pelseneer (plate 35). The cephalic appendages in Clione, Clionopsis, and Pneumodermon are described. In Clione there are tentacles, properly so called, and buccal cones. In Pneumodermon there are tentacles and two acetabuliferous buccal appendages, and in Clionopsis only tentacles are found. While the author leaves the function of the buccal cones in Clione doubtful, there can be no doubt as to the sucker-like functions of the appendages in Pneumodermon.—Evidence in favour of the view that the coxal gland of Limulus and of other Arachnida is a modified nephridium, by G. L. Gulland, M.A. (plate 36), with a note thereon by Prof. E. Ray Lankester, in which the following important statement is made:—"The space in the connective tissue into which the young nephridium opens internally is *not* a blood space. The blood system in the larger Arthropoda is altogether distinct from the general system of lacunæ of the connective tissue. The *lacunæ* form a *lymphatic system* which contains a liquid distinct from the blood: they represent the body cavity, and as such receive the internal openings of the nephridia."—Notes on the embryology of Limulus, by Dr. J. S. Kingsley (plates 37–39).—On the anatomy of the Madreporaria, part i., by G. Herbert Fowler, B.A. (plates 40–42).—The issue of the "Supplement" numbers of this journal being found inconvenient, it has been decided to publish its numbers for the future at such intervals as the accumulation of material renders desirable. Though more than four numbers will thus in all probability be published in the course of a year, the title will remain unaltered. Four numbers will make a volume.

Two papers are especially noteworthy in the *Journal of Botany* for November:—Rev. H. E. Fox and Mr. F. J. Hanbury's "Botanical Notes of a Tour in Caithness and Sutherland," where they had the opportunity of visiting large tracts of country from which botanists are, as a rule, now practically shut out, that they may not interfere with the sports of the owners; and Mr. F. N. Williams's careful "Enumeration of the Species and Varieties of *Dianthus*."

The number for December is signalised by a continuation of the record of Mr. Thos. Hick's important observations on protoplasmic continuity in the Fucaceæ. He has now detected this continuity in two other species, *Hemanthalea lorea* and *Laminaria digitata* (the latter not strictly belonging to the Fucaceæ), in the cortical and central, less certainly in the epidermal tissue. In the latter species the continuity is effected through the intervention of sieve-plates. Mr. James Britten gives a complete history of the important botanical collections made by Messrs. J. R. and G. Forster.

The Proceedings of the Linnean Society of New South Wales, vol. x. part 2, July 31, contains the following papers:—W. Macleay, revision of the genus Lamprina, and descriptions of new species; on two new Australian Lucanidæ; on new fishes from the Upper Murrumbidgee.—N. de Miklouho-Maclay, on the zoology of the Maclay coast, New Guinea, ii.; on two new species of Dorcopsis (plates 19 and 20); on the brain of *Halicore australis* (plate 24).—Dr. R. von Lendenfeld, on Australian sponges lately described by Carter; on a Medusa from the tropical Pacific.—A. G. Hamilton, on the fertilisation of *Goodenia hederacea* (plate 21).—K. H. Bennett, on the habits of *Falco subniger* and *Glareola grallaria*.—Rev. J. M. Curran, on the geology of Dubbo (plates 22 and 23).—Baron von Mueller, on a remarkable Haloragis from New South Wales.—A. S. Olliff, the Cucujidæ of Australia.—D. Ogilvy, description of new fishes.—E. P. Ramsay, notes on birds from New Guinea; on a new species of Collyriocincla.—G. F. Mathew, R.N., on the natural history of Claremont Islands; on the butterflies of Thursday Island.—W. A. Haswell, M.A., jottings from the biological laboratory of Sydney University.

Zeitschrift für wissenschaftliche Zoologie, Band 42, Heft 3, October 27.—On the movements of the foot in the Lamellibranchs, by Dr. A. Fleischmann (with five woodcuts).—On the oceanic fauna off the coast of New Guinea, by Dr. R. Greeff (plates 12–14). Rolas or Pigeon Island is separated from St. Thomas by a channel of from 3 to 4 km. wide. Under favourable winds, shoals of larval and mature Crustacea, Mollusca, Echinoderm larva, Medusa, Radiolaria, &c., float through. The general description of the place is most alluring; surely the proprietor, Mr. F. José de Araujo is in the possession of an earthly paradise for a marine zoologist. In this memoir Dr. Greeff describes and figures several new species of Tomopteris and Alciope, giving, at the same time, anatomical details.—Contributions to the anatomy and histology of *Priapulus caudatus*, Lam., and *Halicryptus spinulosus*, V. Sieb., by Dr. W. Apel (plates 15–17).—Contributions to our knowledge of the Mallophaga, by Dr. F. Grosse (plate 18). These researches are chiefly based on a remarkable new parasite from a pelican found by Dr. Reiss in Chili, which is described as belonging to a new genus and species (*Tetrophthalmus chilensis*).—On the reproductive organs in *Nematois metallicus*, Pod., by N. Cholodkovsky (plate 19), a memoir of importance to the Lepidopterist.

Archives Italiennes de Biologie, tome vi. fasc. 2, March 31, contains:—Clinical and physiological researches on paraldehyde, by Dr. V. Cervello.—On the physiological action of antipyrene, by Dr. F. Coppola.—On perimetry, and on self-registering perimeters, by Dr. Ferri.—On the effects of salt on Cercaria, by Prof. E. Perroncito.—On cicatrisation after wounds in the kidney; and on the partial regeneration of that organ, by G. Pisenti (plate).—On albumen in the saliva, and the bile in albuminuria, by Matilda Dessalles.—On the minute structure of the air-sacs in birds, by Dr. E. Ficalbi (abstract).—On anomalies in the number of the semi-lunar, aortic, and pulmonary valves, by G. Martinotti, and G. Sperino.—On microphytes in the normal human epidermis, by Prof. G. Bizzozero (from *Virchow's Archiv*), December, 1884 (plate).—On the organ of Corti in the Cercopitheci, by Prof. A. Tafani (illustrated).—Notes on the anatomy of a negro (iii.), by Prof. Giacomini (plates).

THE October number of the *Nuovo Giornale Botanico Italiano* contains only two original papers:—On the Bryology of the neighbourhood of Cuneo, by Sig. Macchiati; and On the nature and development of the integuments of the seed in *Tilia*, by Sig. Mattirolo. These integuments may be classified into two layers, the inner of which displays the light line characteristic of the genus *Tilia*, and which is due to the formation of lignin.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 17.—"A New Form of Spectroscope." By J. Norman Lockyer, F.R.S.

Some two or three years ago, when the sun-spot work carried on at Kensington revealed the different behaviour, in different spots, of lines visible in the spectra of the same element, it seemed desirable to extend similar observations to metallic prominences, and, if possible, in such a way that comparisons over a considerable reach of spectrum should be secured.

It then struck me that a grating cut in half, with one part movable, would afford a ready means of doing this.

Circumstances prevented the realisation of this scheme till quite recently, when I put into Mr. Hilger's hands a grating presented to me by Mr. Rutherfurd.

The result is excellent. It is possible to observe C and F, for instance, together, quite conveniently, with either a normal or a tangential slit. The only precautions necessary are to see that one-half of the light passing through the object-glass falls on one-half of the grating, and that the rays which come to a focus on the slit plate are those the wave-length of which is half way between the wave-lengths compared.

Linnean Society, December 17.—Mr. Frank Crisp, LL.B., Vice-President and Treasurer, in the chair.—*Heritiera littoralis*, var. *macrophylla*, Dr. Masters showed a branch with leaves and fruit, received from Prof. Cornu, of the Jardin des Plantes, Paris. The adult leaves, of very large size, are dark green above, and silvery white beneath. The latter, due to an investment of shining, peltate, membranous scales, has given rise to the name "Looking-glass tree." This Sterculaceous tree is a native of the tropics of the Old World, in the vicinity of coasts, and occurs inland in the hills of Eastern Bengal. Kurz considered the species and its variety as quite distinct, a view not held by Dr. Masters.—Mr. Charles Stewart exhibited the stridulating organ of a Spiny Lobster (*Palinurus*); he showed under the microscope the file-like bow and its two tubercles, also, by means of a softened specimen attached to the carapace, he produced the peculiar grating noise which the animal makes during life.—Mr. J. G. Baker exhibited specimens of *Lycopodium complanatum*, collected by the Rev. A. Lawson on the Somersetshire side of Exmoor, near Porlock, thus corroborating those who have ascribed a British habitat to the species in question.—Mr. Clement Reid drew attention to a series of fossil seeds and plants from the "Forest Bed" of the Cromer district, Norfolk; their very excellent state of preservation enabled their comparisons with living plants to be easily made out, and thus a clue given to the history of our present flora.—Mr. Thos. Christy exhibited a plant of *Angræcum sesquipedale* in flower, and a plant of *Catasetum purum*, showing flowers erect and reversed in the same spike. In none of the flowers was the ovary visibly twisted, but in long ovaried orchids it is often very difficult to detect the twisting of the ovary by the external aspect. This specimen illustrated the fact that light or the absence of light was not the cause of the alteration of position.—The following specimens were exhibited from Mr. E. M. Holmes, viz. :—(1) *Ustilago marina*, Dur., a fungus new to Britain, having been discovered by Mr. Holmes, last autumn, growing on *Scirpus parvulus* at Studland Bay, Dorset, on ground covered by brackish water; (2) fruit of *Afzelia cuanzensis* from Limpopo, Natal, sent him as the pod of a mahogany-tree; (3) fruit of *Trichilia Dregei*, from the same district,—oil is obtained from the seeds by boiling, and with this insecticide the Kaffirs anoint their bodies.—Mr. F. R. Cheshire gave an epitome of his late researches on the tongue of the bee, describing the structure and mode in which he believes suction of nectar takes place.—A paper was read, on Entomostraca collected by Mr. A. Haly in Ceylon, by Prof. G. S. Brady. The freshwater forms were obtained at Colombo; the marine species were dredged at a depth of two fathoms in the Gulf of Manaar. The freshwater Copepoda and Cladocera approach well-known European species. Among the Ostracoda is a curious new generic form, *Cyprinotes*. Additional information is also given by the author respecting *Cypris cylindrica* (*Malcolmsonia*) and *C. subglobosa*.—Mr. H. N. Ridley read a paper on orchids from Madagascar. The collection (fifty in number) was obtained by Mr. Fox in the neighbourhood of Imerina. Among them are three genera new to the flora of the island, viz. *Arnottia*, indigenous to the Mauritius; *Brownleea*, hitherto only known from South Africa; *Holothrix*, an East African representative. Another interesting novelty is *Satyrium gigas*.—Two other papers, read in abstract, were: a monographic revision of the recent Ephemeridæ, part iv., by the Rev. A. Eaton; and Colombian species of the genus *Diabrotica*, part ii., by Mr. Joseph Baly.

Anthropological Institute, December 8.—Mr. Francis Galton, F.R.S., President, in the chair.—Mr. H. H. Johnston exhibited a collection of photographs of African natives and scenery.—Mr. H. W. Seton-Karr exhibited a number of photographs of North American Indians, taken by him during his recent visit to Canada.—Mr. Joseph Hatton exhibited several ethnological objects collected by his son, the late Frank Hatton, in North Borneo. Mr. W. M. Crocker also exhibited some objects from Borneo; and Mr. R. Meldola exhibited some photographs of Nicobarese.—A paper by Mr. E. H. Man, on the Nicobar Islanders, was read, in which the author described the wild race inhabiting the interior of Great Nicobar and called by the inhabitants of the other islands of the group "Shom Pen." It appears certain that they are the descendants of a very ancient aboriginal population of Mongolian origin. The height of the males appears to range between 5 feet 2 inches and 5 feet 8 inches; their skin is fairer than that of the generality of the coast people, who on their part are less dark than the Malays; the hair is straight, and is commonly worn uncut and unkempt. Their dwellings are small and erected on posts; the floors being raised six or seven feet above the ground necessitates the use of ladders. Mr. Man hopes before long to be able to supplement in many particulars the meagre information that has hitherto been obtainable regarding the Pen, but the task is one of considerable difficulty.

Royal Meteorological Society, December 16.—Mr. R. H. Scott, F.R.S., President, in the chair.—Mr. J. Hartnup, Mr. A. W. Preston, Mr. R. Sheward, and Mr. W. B. Worthington were elected Fellows of the Society.—The following papers were read:—On the influence of forests upon climate, by Dr. A. Woeikof, Hon.Mem.R.Met.Soc. The first step towards a scientific investigation of the influence of forests upon climate was taken by the establishment of the Bavarian Forest Meteorological Stations. This example was followed by Germany, France, Switzerland, Italy, and other countries. As a general result it was found that during the warmer season the air and earth temperatures were lower in the forest, as compared with contiguous woodless places; that their variations were less; and that the relative humidity was greater. Dr. Woeikof's discussion of this question shows that in the western portions of the Old World extensive forests materially influence the temperature of neighbouring localities, and that the normal increase of temperature from the Atlantic Ocean towards the interior of the Continent is not only interrupted by their agency, but they cause the summer to be cooler in regions situated further in the interior than those nearer the sea. Hence, forests exert an influence on climate which does not cease at their borders, but is felt over a greater or less district, according to the size, kind, and position of the forests. From this it naturally follows that man, by clearing forests in one place and planting others in another, may considerably affect the climate.—Report on the phenological observations for 1885, by the Rev. T. A. Preston, M.A., F.R.Met.Soc. The year has been a very dry one, and this has acted in such a manner on vegetation that, although the winter was mild, plants were very late in flowering, and lasted only a short time. The bloom was often profuse, and, as bees and other insects could visit them, the crop of fruit was unusually great—the apples, for instance, being often spoilt in quality from the enormous number on the trees; whilst in the case of wild fruits the brilliant colour of the bushes when in fruit was quite as beautiful as when in bloom. But at the same time the drought acted very prejudicially, especially to root-crops and bush-fruit, as well as strawberries. In the case of the root-crops, the seed had great difficulty in germinating, and the weak plants were at once overpowered by insect pests, so that the crops of turnips were generally complete failures. The insect pests also did much damage to bush-fruit, while the drought prevented the strawberries from swelling. The corn did not suffer to any great extent, the dry season allowing the land to be prepared: and, although the straw was often short, the yield was not unsatisfactory. A general absence of butterflies was noticed in some places. In the south of England the white butterflies were most abundant at one time, but the autumn butterflies were not so plentiful as usual.—Etudes sur les crépuscules rosées, by Prof. A. Ricco, of Palermo.—The storm of October 15, 1885, at Partenkirchen, Bavaria, by Col. M. F. Ward, F.R.Met.Soc. This was the most destructive storm which has occurred in this valley since the winter of 1821–22. The storm burst suddenly at 7 p.m., and lasted about half an hour, but in that short period nearly every house was unroofed, and it is computed that in one forest alone above 250,000 trees were laid prostrate.

Geological Society, December 2.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Charles Dawson, Francis J. Ede, Lewis Edmunds, Henry A. Gordon, George Frederick Harris, Samuel Learoyd, John Main, Mansfeldt Henry Mills, Rev. Thomas Randell, James Radcliffe, Andrew Edmund Castlestuart Stuart, Tudor Gruffydd Trevor, and Arthur Smith Woodward were elected Fellows of the Society.—The following communications were read:—On some borings in Kent; a contribution to the deep-seated geology of the London Basin, by W. Whitaker, B.A. (Communicated by permission of the Director-General of the Geological Survey.) Seven deep borings in the eastern part of Kent were described, all of them reaching to the Gault. The chief one is at Chatham Dockyard, where, after passing through the whole thickness of the Chalk, the Gault was found to be 193 feet thick, whilst the Lower Greensand was only 41 feet, and was underlain by Oxford Clay, a formation not before known in Kent. These parts involve the thinning of the Lower Greensand from 200 feet at the outcrop a few miles to the south, and the entire loss of the whole of the Wealden series, which, further south, exists in great force, the Weald Clay being 600 feet thick, or perhaps more, and the Hastings Beds 700 feet or more. Still further south, in the central part of the Wealden district, there are outcrops of the Purbeck Beds, whilst the Subwealden boring continues the series downwards. We have thus an addition to the beds wanting at Chatham of some 400 feet of Purbeck and Portlandian, of over 1100 feet of Kimeridgian, and of nearly 500 feet of Corallian, &c. In a section of 32 miles, therefore (the distance between the Subwealden and the Chatham borings), we have a thinning of beds to the extent of over 3400 feet, or at the average rate of about 100 feet in a mile. This northerly thinning agrees with the facts that have been brought before us from other deep borings in and near London; but the Chatham boring is the first in the London Basin in which a Middle Jurassic formation has been found. The teaching of the deep borings, as a whole, is that north of the Thames older rocks rise up beneath the Cretaceous beds, whilst on the south newer rocks come in between the two. The question of the finding of the Coal-measures beneath parts of the London Basin seems to admit of a hopeful answer, whilst the lesson of the deep borings as regards water-supply is that there is small chance of getting water from the Lower Greensand at great depths underground. It would be well if underground exploration could be conducted on a systematic plan, with proper regard to both topographical and geological considerations, and not left any longer to the chance work of people in search of water.—Note on some recent openings in the Liassic and Oolitic rocks of Fawler in Oxfordshire, and on the arrangement of those rocks near Charlbury, by F. A. Bather; communicated by Prof. J. Prestwich, F.R.S. The River Evenlode rises in the Lower Lias of the Vale of Moreton, traverses the range of Oolites, and joins the Isis opposite Wytham Mill. Lias is exposed to about three-quarters of a mile below Fawler, where Great Oolite is brought down by a fault; and in the Geological Survey map Lower Lias is brought down the valley to within half a mile of Charlbury railway station. In this paper the author gives reasons for believing that the distribution of the different beds constituting the Lias in the Evenlode Valley do not agree with the Geological Survey map, nor with Prof. Hull's description; recent sections and borings made for clay, used in brick- and pottery-making, having exposed Lower Lias clay in a brick-yard at Fawler, Marlstone and Upper Lias clay in a neighbouring coombe, and in a long section 100 yards north of the brick-yard Inferior Oolite comes in upon the Upper Lias clay. On examining the banks of the Evenlode, north of Charlbury, it was found that clays referred in the Survey map to Lower Lias are really Upper Liassic, being above the Marlstone, sections of which are exposed near Culsham Bridge. It was shown how these corrections in the mapping of the ground are explained by the section along the line of the Evenlode and by the dips of the beds.

Royal Microscopical Society, December 9.—A. D. Michael, F.L.S., Vice-President, in the chair.—Mr. Swift's large photo-micrograph of the tongue of the blow-fly, which had obtained the prize medal at the recent Exhibition of the Photographic Society, was exhibited. The plan adopted was to take an enlarged photograph from a small image obtained by a paraffin lamp by artificially strengthening the image where required.—Mr. Crisp exhibited Prof. Klein's microscope for observing crystals when heated to a high temperature; also an apparatus for enabling four photo-micrographs to be taken of the same object, so as to give a different length of exposure to each or to photograph different parts of an object rapidly.—Dr. Maddox exhibited a series of photographs of inked surfaces covering pencil lines. Mr. Crisp referred to a curious case in which a forger wanted to add some words to a bond which had been originally written with very pale ink. The added words were darker, and he therefore retraced the whole of the original writing to make it look all alike, but examination with the microscope at once detected the forgery.—Dr. E. Crookshank read a paper on the cultivation of bacteria, which he illustrated by numerous drawings and by a series of preparations. He also exhibited and described a collection of apparatus of the latest and most approved construction for the cultivation of bacteria and the preparation of the media employed.—Mr. Robertson described a method of preparing a section of spinal cord by soaking in picrocarmine before cutting.—Mr. Meates's note on a new highly-refractive medium for mounting sulphide of arsenic was read.—Mr. Cheshire read a paper on the pulvillus of the bee, calling attention to a notch found upon the leg of the bee, and explaining what he considered to be its function as opposed to the explanations given by some other observers.—Mr. J. W. Groves exhibited some mounted sections cut by the large Barrett microtome to show how large good sections could be made with the machine.—Eleven new Fellows were elected and proposed.

DUBLIN

Royal Society, November 18.—Physical and Experimental Science Section.—Prof. W. F. Barrett in the chair.—On the beryls and iolite of Glencullen, co. Dublin, by J. Joly, B.E. The beryls of Glencullen, while presenting the angles and faces of normal beryl, are found, on microscopic examination, to consist of a mixture of beryl and orthoclase. The latter mineral amounts sometimes to 72 per cent. of the entire crystal. There is evidence that this phenomenon was produced by alteration, not by inter-crystallisation in the first instance. The orthoclase contains much iolite in sharp well-defined crystals. The beryls of the Dublin granite lose all colour when heated for a few days to a temperature of about 300° C. An hour's heating at 350° C. deprives them of colour. The bearing of this phenomenon on the history of the granite is pointed out by the author.—On the absolute weights of the chemical atoms, by G. J. Stoney, D.Sc., F.R.S.—On a new form of instrument for determining the magnitudes and colours of stars, by John Ballot; communicated by Howard Grubb, M.E., F.R.S. The apparatus consists of an arrangement attachable to the draw-tube of a telescope, by means of which an image of small illuminated apertures can be thrown into the field of the eye-piece and viewed by an observer at the same time as the image of the star formed by the objective. The light is supplied by a small incandescent Swan's light condensed by a reflector, and is passed through four sets of slides or revolving wheels, the first containing a wedge of neutral-tinted glass, the second a set of microscopic apertures of varying sizes, and the third and fourth sets of seven coloured glasses. By those four slides it is possible to regulate the size, colour, and intensity of the ghost-star, and thus form a standard by which the magnitude and colour of any star can be determined. The two coloured slides are supplied in order that secondary tints may be obtained by combination of any two primary colours. The accuracy of the instrument depends of course on the constancy of the lamp. This constancy can be obtained, within moderate limits, by proper electrical contrivances, but reference should occasionally be made to standard stars. Even though the source of light be not absolutely constant, it appears probable that a better result will be obtainable by such an apparatus than by any in which the constancy of sensitiveness of the human eye has to be depended upon from observation to observation.—Thomas Edmondson exhibited the new circular calculating-machine invented by Joseph Edmondson, Halifax.—Howard Grubb exhibited Wilson's new sunshine-recorder.

Natural Science Section.—Presidential Address to the Royal Geological Society of Ireland by Prof. J. P. O'Reilly, C.E., M.R.I.A., &c.—Note on *Halcampa chrysanthellum*, Peach, by Prof. A. C. Haddon. A full and critical note on this species, which is shown to embrace *H. vittata*, Kef., *H. bilateralis*, Kef., *H. kefersteini*, Andr., and *H. adresii*, Hadd.—On certain sense-organs occupying the perforations in the shell of the Brachiopoda, by Prof. Sollas, D.Sc., &c. The cæcal processes occupying the canals in the Brachiopod shell are extensions of the outer epithelium of the mantle. At the outer end, which lies immediately beneath the chitinous periostracum, each terminates in a large cell with a large nucleus and nucleolus, invested by other smaller cells. The large cell is continued into a nerve-fibril, which runs axially down the cæcal process, and enters the nervous layer of the mantle. This is the structure of a sensory end-organ, which in this case seems to transfer luminous radiations.—Additional note on *Macrozamia denisonii*, by Prof. W. R. McNab, M.D. This Cycad, known in gardens as *M. denisonii*, but which botanically is *M. perowskiana*, Miguel, has recently produced a fine female cone in the Royal Botanic Garden, Glasnavin, and was noticed at the June meeting of the Society. The cone was cut on September 1, and shows in a very beautiful manner the close series of small sterile scales which form the whole base of the sessile cone. Although the cone looked a terminal structure, it forms a lateral branch, and now (November) the young leaves are developing from the growing axis.—On New Zealand Coleoptera, by D. Sharp, M.B. No beetles from New Zealand were known to Linnæus, and up to 1867 about 150 species had been noted; now about 1500 species are known to the author, who estimates that the Coleoptera of New Zealand will probably number from 3000 to 3500. In the present paper a special scrutiny is made of the Pterostichini and Otiorhynchini. The Coleopterous fauna is analogous to that of Europe and other continental regions, but contains a large proportion of forms which are to be regarded as little evoluted. Cetoniadæ are wanting, and the Buprestidæ are represented by two minute and obscure forms. The Phytophaga, which, like the two preceding groups are remarkable for the brilliancy of their colouring, are few in number, small in size, and dull coloured. So also with the weevils. There are no Longicornes with tufted antennæ, and no horned Lamellicornes. The Coleopterous fauna is remarkable for the number of isolated forms which have little or no connection with the ordinary forms of the island. The Coleopterous fauna of New Zealand seems to have most affinity with that of Chili and Patagonia, and but little with the Australian fauna, many of the most characteristic Australian forms being wholly unrepresented in New Zealand.

SYDNEY

Royal Society of New South Wales, August 5.—Prof. Liversidge, F.R.S., President, in the chair.—The Rev. P. MacPherson, M.A., read a paper on some causes of the decay of the Australian forests. Photographs of a tree near the Lane Cove Road, which measured about 25 feet in circumference at a height of 30 feet from the ground, were shown by Mr. H. C. Russell, B.A. He thought that such a rare relic of a past era in the forest-growths of Australia should not be lost, and moved that the Government be asked to reserve the ground on which it stands.

PARIS

Academy of Sciences, December 14.—M. Jurien de la Gravière, Vice-President, in the chair.—Movements of the molecules of the so-called "solitary wave" propagated on the surface waters of a canal (continued), by M. de Saint-Venant.—On a method of analysis applicable to the study of the hydrocarburet mixtures of the aromatic series, by MM. C. Friedel and J. M. Crafts. By the process here described all the four isomeric bodies answering to the formula C_8H_{10} (ethylbenzene and the three xylenes) become transformed to substances as easily separable as most bodies dealt with in mineral analysis. Not only is this effected without loss of matter, but the combinations when finally analysed are found to possess from five to seven times the weight of the hydrocarburet used in the analysis.—Remarks on the new specimens recently deposited in the Palæontological Department of the Museum, by M. Albert Gaudry. Amongst these is the entire skeleton of a fossil edentate (*Scelidotherium leptocephalum*) from the Buenos Ayres district, apparently a contemporary of the Megatherium and Glyptodon; also a remarkably well-preserved Mystriosaurus, and castings of a New Zealand Megalania, of a Russian Elasmotherium, and of some Dinoceras from the Rocky Mountains.—Claim of priority for the use of the sulphate of copper against brown rust vindicated for M. Benedict Prevost, by M. de Lacaze-Duthiers.—On a new theory of algebraic forms, by Prof. Sylvester.—On the propagation of the movement in an indefinite fluid (second part), by M. Hugoniot.—Remarks on the *Annuaire* for the year 1886, presented to the Academy on behalf of the Bureau des Longitudes, by M. Faye.—Remarks on MM. Faudel and Bleicher's "Materials for the Study of Prehistoric Alsace," presented by M. Hirn.—Observations of Fabry's comet and of Barnard's comet made at the Observatory of Algiers with the 0·50m. telescope, by M. Trépied.—Observations of Barnard's new comet made at the Paris Observatory equatorial of the West Tower), by M. G. Bigourdan.—Note on the construction of the large double-meridian circles, by M. Gruey.—On a new class of integrable linear differential equations, by M. Halphen.—On a new method of generating unicursal algebraic curves, by M. G. Fouret.—On the movement of a point in a plane and on imaginary time, by M. L. Lecornu.—On certain geometrical surfaces of the third order possessing an infinite number of umbilici, by M. A. de Saint-Germain.—On the construction of machines intended for the electric transmission of power in connection with the electric machines at present working between Creil and Paris, by M. Marcel Deprez.—An inquiry into the causes that have momentarily arrested the experiments on the transmission of power between Creil and Paris, by M. A. Sartiaux. The accident, the first recorded for over a month, was shown to be caused by defective isolation along the line of transport resulting from accidental communications with the earth, which may easily be avoided in future.—Note on the relations existing between the absorption of light and the emission of phosphorescence in compounds of uranium, by M. H. Becquerel. The molecular state of these compounds causes them to exercise on light an elective absorption of harmonic radiations, while some of them emit by phosphorescence inferior harmonic luminous radiations of the absorbed rays. The absorption seems due to vibratory motions caused by the influence of the incident radiations, and apparently synchronous with the absorbed rays.—Spectrum of the nitrogen bands: its origin, one illustration, by M. H. Deslandres. With the aid of M. Cornu's photographic apparatus, the author has determined beyond all doubt the origin of a whole group of these ultra-violet bands, which form the spectrum of a nitrogen and oxygen compound, so far confirming Angström's well-known view.—Note on the diffusion of heat, by M. Léon Godard.—A study of the hydrates of arsenic acid ($AsO_5,3HO$, and $AsO_5,2HO$), by M. A. Joly.—Researches on the formation of the vast deposits of nitrate of soda in certain parts of South America, by M. A. Müntz. This nitrate appears to be the result of a double decomposition between the nitrate of lime and marine salt. But it was not formed in the places it at present occupies, where it has been gradually concentrated under divers outward influences.—Fresh researches on the various compounds of proteine, by M. Paul Schutzenberger.—Note on the preparation of benzoylcyanacetic ether and of cyanacetophenone, by M. Haller.—On the accumulation of nitrogen in ground kept constantly under grass, by M. P. P. Dehérain.—Note on a microbe whose presence seems to be connected with the development of rabies, by M. H. Fol.—On the construction of the jaw-bones of vertebrate animals, by M. A. Lavocat.—On the development of the basin in the cetaceans, by M. H. P. Gervais.—On the development of the horny layer in the gizzard of poultry, and of the glands secreting it, by M. Maurice Cazin.—On the development of the tonsils in mammalians, by M. Retterer.—Researches on the comparative anatomy and physiology of the trigeminal, facial, and cephalic sympathetic nerves in birds, by M. Laffont.—Remarks on two species of Balanoglossus (*B. hacksi*, from Japan, and *B. talaboti*, from the district of Marseilles), by M. A. F. Marion.—On the skeleton of the extinct genus Scelidotherium, recently deposited in the Paris Natural History Museum, by M. P. Fischer.—On the action of chlorophyll on the carbonic acid outside the vegetable cell, by M. P. Regnard.—Note on the stratigraphic structure of the Menez Hills, Brittany, by M. Charles Barrois.—A chemical study of the substances brought up during the soundings of the *Travailleur* and *Talisman* Expeditions: constant presence of copper and zinc in these deposits, by M. Dieulafait.—On the non-nitrous or slightly nitrous diet usually recommended in the case of diabetes, by M. Boucheron.—Note on some fresh documents advanced to support the theory of a cosmic origin of the late crepuscular glows, by M. José J. Landerer.

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THURSDAY, DECEMBER 31, 1885

TERTIARY VERTEBRATA OF THE WEST

Report of the United States Geological Survey of the Territories. F. V. Hayden, United States Geologist-in-Charge. Vol. III. "The Vertebrata of the Tertiary Formations of the West." Book I. By Edward D. Cope. (Washington, 1883-1884.)

THE American Government has in many ways shown the importance which it attaches to the diffusion of scientific knowledge; but in nothing has this been more clearly seen than in the care with which the results of the Geological Surveys have been published, and the liberality with which these works have been distributed; so that geologists on this side of the Atlantic are well acquainted with the magnificent quarto volumes in which the Reports of the Geological Survey of the Territories have been published. A number of these volumes had already appeared under the directorship of Dr. F. V. Hayden, when, in the year 1882, their publication was committed to the charge of Major J. W. Powell, Director of the United States Geological Survey. The work now before us is the first Report of the Survey of the Territories published since this change, and will take its place as the third volume of the series. While fully equal to the previous reports in the care bestowed upon the drawing and printing, it is by far the largest volume which has yet appeared, comprising, as it does, more than a thousand pages of letterpress and upwards of one hundred lithographic plates.

Prof. Cope began this work in 1872, and since then it has been carried on both in the field and in the study. It was originally intended that the Vertebrata of the "Cenozoic" and "Mesozoic" formations should form the third and fourth volumes of the Reports, but such a large amount of material has been obtained that it has become necessary to limit the work to the description of the "Cenozoic" Vertebrata, and this is to be divided into four parts, thus:—

Part I. Puerco, Wasatch, and Bridger Faunæ (Eocene).

Part II. White River and John Day Faunæ (Low. and Mid. Miocene).

Part III. Ticholeptus and Loup Fork Faunæ (Upper Miocene).

Part IV. Pliocene.

The present volume includes Part I. and Part II. as far as the Carnivora, the number of species described being 349, included in 125 genera, no less than 317 species having been determined by Prof. Cope.

The explorations, resulting in the acquisition of this splendid series of fossil Vertebrata, were conducted chiefly by the author himself, assisted by an efficient staff, and were carried on with much trouble and personal risk, not only on account of the inhospitable country in which part of the explorations had to be made, but also because of the hostility of the Cheyenne Indians, who, in certain regions, were during this time continually committing depredations and murders. No little credit is due to Prof. Cope and his able coadjutors for the manner in which this work was carried to so successful an issue in the face of many difficulties.

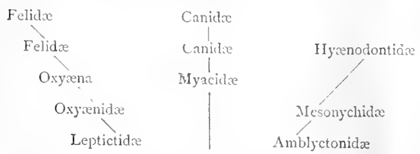
Before entering upon the description of the fossils, a short account is given of the Tertiary formations in which they were found, and an interesting and valuable comparison is made with the strata of the same age in Europe. A significant circumstance, with which geologists are to some extent already familiar, is the different story, regarding the age of these beds, told by the plants and mammals. The determination of the age of the formations known as the Loup Fork, White River, Bridger, Wasatch, Green River, and Laramie Beds, arrived at by Prof. Cope from a study of their higher vertebrate faunæ, does not agree with the conclusions of Mr. Lesquereux derived from his examination of the plant remains. The table given at p. 44 shows, in each case, the Flora a whole period in advance of the Vertebrata; for example, while the Laramie plants have an Eocene facies, the Vertebrata indicate an Upper Cretaceous age; and the fauna and flora of each of the other formations show a similar discrepancy.

The numerous *Bulletins* and reprints with which Prof. Cope has liberally supplied us during the last few years have made us to some extent acquainted with the progress of the laborious task which he has undertaken, and with the names proposed for some of the new types of animals which have been discovered. Even with this knowledge, however, one is perplexed, on first opening the book, with the array of new names. The overwhelming amount of material which had to be dealt with, including such a multitude of new forms, no doubt made it necessary to establish many new genera and species, and these would require, in some instances, to be placed in new groups; but, notwithstanding this, it will probably be felt by many palæontologists that it would have been better in some instances to extend the limits of a group rather than to make new ones. Be that as it may, Prof. Cope has laid us under no little obligation by giving us such a clear and systematic account of his herculean labours.

In the author's preface he touches upon the troublesome question of the rules of nomenclature. While agreeing with the law of priority, as generally understood, he gives half a dozen rules which have been adopted by a number of American biologists. The main principle underlying all these rules is, that a generic or specific name given by any author, without a sufficient description or definition, is not entitled to recognition by subsequent writers. To this principle no naturalist will be likely to take exception; but, unfortunately, the manner in which this rule has been applied by some authors has produced a result which it is most desirable to prevent, that is, an unnecessary multiplication of names. To take an instance, a writer (A.) describes a number of new species, giving them a generic name, without any definition, and, to quote Prof. Cope, "In these cases it is left to the reader (B.) to discover their characters. Should he do so, he becomes the real discoverer of the genus, and, as such, is entitled to name it." No doubt Mr. A. should have characterised his genus, and his name is *not entitled to be received;* but if Mr. B. is a true man of science, he will forego his right and "habilitate the *nomen nudum*," rather than burden his brother-workers with another addition to their load of synonyms, which is already a burden almost too heavy to be borne.

This volume is essentially a detailed description of genera and species, and as such is an extensive and invaluable mine of information, wherein palæontologists may work with profit for many years to come. But besides the more special descriptions, there is much of deep interest to the naturalist and evolutionist, a flood of light being thrown on the early Eocene forms, which were probably the progenitors of our existing mammals.

The Saurian genus *Champsosaurus*, hitherto known only from Cretaceous deposits, has now been found in the Puerco Tertiary series. The remarkable marsupial genus *Plagiaulax*, was originally described by Falconer from British Purbeck beds; within the last few years an almost identical genus has been met with in Tertiary strata in France; and now closely allied forms are made known to us from the American Tertiary groups. It is, however, among the higher mammalia that the most remarkable discoveries have been made. The finding of forms, less specialised than those living at the present day, has enabled Prof. Cope to trace what he believes to be the line of descent of some of the groups of living mammals. The determination of the characters of a considerable number of new genera and species, more or less closely allied to the *Insectivora*, has led to a new classification. It is proposed to include in a new order, called the *Bunotheria*, the sub-orders:—(1) *Creodonta*, (2) *Mesodonta*, (3) *Insectivora*, (4) *Tillodonta*, (5) *Tæniodonta*, and (6) *Prosimiæ?* The *Creodonta* come nearest to the *Carnivora*, while the *Prosimiæ* come nearer to the *Quadrumana*, groups (4) and (5) being distinguished by the possession of incisor teeth with persistent pulps. It is among the Eocene *Creodonta* that Prof. Cope finds the ancestors of the *Felidæ* and *Canidæ*. "In distinguishing between the ancestors of the *Felidæ* and *Canidæ*, we naturally seek to recognise in each an anticipation of the leading characters in the dentition which distinguish those families to-day" (p. 263). In the *Felidæ* we should expect a gradual abbreviation of the true molar series from behind. The *Canidæ*, on the other hand, not only retain the true molars, but have them also of a tubercular character. "Estimated by these tests the *Myacidæ* are clearly the forerunners of the *Canidæ*, and the *Oxyænidæ* of the *Felidæ*." The following diagram will show the families through which these relations are traced (p. 264):—



Unfortunately the new names prevent our fully appreciating these affinities, which can only be properly understood when the characters of these groups have been carefully studied. The forms allied to *Canis* which have been met with in the Lower and Middle Miocene are all said to be generically distinct from *Canis*, while those from the Upper Miocene pertain to the same genus The many new species of *Carnivora* have suggested to Prof. Cope a new grouping for the *Fissipedia*. These are in the first place divided into two subdivisions:—

(1) "External nostril occupied by the complex maxilloturbinal bone; ethmoturbinals confined to the posterior part of the nasal fossa; the inferior ethmoturbinal of reduced size . . . *Hypomyceteri*.

(2) "External nostril occupied by the inferior ethmoturbinal and the reduced maxilloturbinal . . . . *Epimyceteri*."

No. 1 includes the families *Cercoleptidæ*, *Procyonidæ*, *Mustelidæ*, *Æluridæ*, *Ursidæ*, *Canidæ*.

No. 2 the *Protelidæ*, *Arctictidæ*, *Viverridæ*, *Cynictidæ*, *Suricatidæ*, *Cryptoproctidæ*, *Nimravidæ*, *Felidæ*, *Hyænidæ*.

The species of *Carnivora* described are from the Miocene, and are all referable to the *Canidæ* and *Nimravidæ*, the first being divided into eight genera, all of which are represented except *Canis*; they have much resemblance to our dogs and foxes, and are separated chiefly by the modifications of their teeth. The second includes nine extinct genera, all closely allied to the *Felidæ*, but differing in having an alisphænoid canal and post-glenoid foramen. In some of them the dental formula is the same as that of the *Felidæ*; but in others there is an increase in the number of the molars and premolars. It is these variations which are used as generic distinctions. Some of the genera, such as *Pogonodon*, have the canine teeth so largely developed as to make a near approach to the sabre-toothed tigers.

The changes which are proposed in the names and grouping of the herbivorous animals are not less numerous or less radical than those among the flesh-eaters, to which allusion has been made above. The order *Ungulata*, as it is now generally understood, is to be divided into four orders, founded on characters of the carpus and tarsus; these are as follows:—

(1) *Taxeopoda* (including sub-orders *Hyracoidea*, *Condylarthra*, and *Toxodontia* ?).

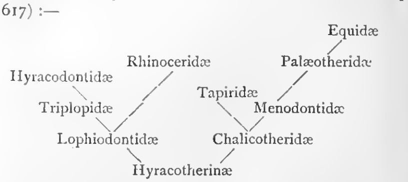
(2) *Proboscidea*.

(3) *Amblypoda* (including *Pantodonta*, *Dinocerata*, and *Talligrada*).

(4) *Diplarthra* (including *Perissodactyla* and *Artiodactyla*).

The necessity for some modification of this classification is already pointed out by Prof. Cope himself, for on p. 383, in speaking of the almost perfect skeletons of *Phenacodus primævus* and *P. Vortmani*, which genus is placed in the *Condylarthra* (Order 1), he says:—"The unexpected result is, that this genus must be placed in a special group of an order which includes also the *Proboscidea*."

Not the least important outcome of these discoveries in the Eocene deposits is the reconstruction, from numerous specimens, of the genus *Hyracotherium*; and consequent upon this the knowledge that it is, as Prof. Cope thinks, the earliest ancestor of the *Perissodactyla*. The following genealogical tree will show this relationship (p. 617):—



The *Hyracotherinæ* are here made the parent stock from which are supposed to have arisen, on the one side, the horses, through the Palæotheria; the tapirs being an offshoot from an ancient group, the Chalicotheridæ. On the other side the rhinoceroses have arisen from the Lophiodonts, from which also the Hyracodonts are to be traced.

Time alone will show whether the systems of classification proposed by Prof. Cope are founded on sufficiently important characters to render them permanent. It is probable that naturalists will hesitate before accepting such sweeping changes, especially as they necessitate the adoption of so many new ordinal names. However, it will be well to wait until we have had time to make ourselves thoroughly acquainted with the details of this work, before criticising that which is the result of years of patient labour. We are certainly under deep obligation to the author for his careful and systematic marshalling of the multitude of facts with which he has had to deal; and congratulate him, as well as the directors of the two Surveys, on the successful completion of this first half of the work, which will be a lasting testimony to the zeal and devotion of all who have shared in the labour of its production, and an enduring monument to its author's scientific skill and untiring energy.

E. T. NEWTON

THE DEPTHS OF ALPINE LAKES

La Faune profonde des Lacs suisses. Par le Dr. F. A. Forel, de Morges, Professeur à l'Académie de Lausanne. (Bâle, Genève et Lyon: chez H. Georg, 1885.)

PROFESSOR FOREL, of Morges, already so well known by his numerous pamphlets and short notices on various points in the natural history and the physical geography of the great lake beside which he lives, has in the present work given us the results of the labours of many years, casting into one mass the many fragments and gathering together and correcting where needful the many interesting papers which alone he has hitherto published.

It is a small quarto volume of over 200 pages, with a table of contents and a long bibliographical list appended; it is a pity that there is no index, and the value of the work would have been greatly enhanced had it been illustrated with figures of the new or rare species, and especially with a map of the basin of one at least of the Alpine lakes. Though it professedly deals with the deep-water fauna of the Swiss lakes as a whole, and though frequent allusions and references are made to work done by Prof. Forel and others in a very large number of these and of other lakes, this memoir, as is natural, deals most fully with the fauna of one lake only—the Léman. Of the only other great lake on the northern slope of the Alps—the Bodensee—and of the great lakes of the southern slope—Verbano, Lario, and Benaco—we are told but little. This is, however, a matter of the less importance as the physical surroundings which have affected the fauna of the Léman are almost exactly repeated in the other lakes, and the little that is known of their deep-water life is very similar to what we know of that of the Léman. Of this—his own lake—Prof. Forel has given us a study which may be called complete.

The chief agents affecting the life of the lake are temperature and light: of less importance are the shape and capacity of its basin, the matters dissolved in or held in suspension by its waters, the movements—for the most part superficial—to which its waters are subject. And light is a far more important factor than temperature,—it is at a depth of 30 metres, at the depth that is to say at which chlorophyll-forming vegetation ceases that Prof. Forel draws the line separating the littoral and deep regions of the lake: the actinic action of light ceases at 50 metres in summer, at 100 metres only in winter, owing to the greater transparency of the waters at that season.

Speaking of the conditions of this deep region Prof. Forel says: "They all tend to calm, to rest, to absence of movement. Uniformity, monotony, equality, no motion, no variation, such are the general characters of this region, with which we can compare no other region but that of the deep sea." It is after having studied the flora and fauna of this region almost uninterruptedly for six years that he now gives us what he modestly calls a sketch of the results at which he has arrived.

But in order to be able properly to understand the deep-water life of the lake we must first be properly acquainted with the inhabitants of the upper waters, whether of the shore or of the open. To this end, the first half of the book is occupied with a careful account of the littoral and pelagic flora and fauna. The most interesting point in this section is the statement that the same species of pelagic Entomostraca are common not only to the Alpine lakes but to those also of Scandinavia and the Caucasus. They exist in enormous numbers, thousands of individuals may be captured in one sweep of the net, and they form a very important part of the food of fishes, giving to them, it appears, their characteristic fishy smell; but the species are few. The very wide distribution of these few species is probably brought about by migratory water-fowl.

The deep-water flora of the Léman finds its lowest limit at a depth of 100 metres, and consists entirely of Algæ, chiefly Palmellaceæ and Diatomaceæ, of which the latter are the most abundant in species, but the Palmellaceæ are the most important, forming in many places a felted carpet on the surface of the ooze, and thus giving a more solid bottom, on which animals may move or in which they may live.

The population is much denser in the upper part of the deep region than in the lower part, but even in the deepest part life is present; in the upper part hundreds of animals, dead or alive, may often be obtained at one haul. About 100 species (22 of which are new) constitute this fauna:—Fishes, 14; Insects, 3; Arachnida, 9; Crustacea, 16; Hydroidea, 1; Rhizopoda, 13; Cilioflagellatæ, 1; Gasteropoda, 4; Lamellibranchiata, 2; Annelida, 4; Nematoidea, 3; Cestoidea, 1; Turbellariæ, 18; Bryozoa, 1; Rotifera, 2.

The greater part of these species are evidently the descendants of the inhabitants of the shallow waters, and differ from them chiefly in being smaller and less brightly coloured; the eyes are wanting in *Gyrator coccus*, and have a tendency to disappear in other species; the shells of the mollusks are thinner than is usually the case with those of the littoral zone; and *Fredericella Duplessis*, which is the representative of *F. sultana*, has so far varied from the littoral form that it is never found attached to solid bodies, such as pebbles or fragments of coke, but invariably plunged in the soft ooze after the fashion of a Pennatula.

But of two species of Crustaceans—*Niphargus puteanus* var. *Forelii*, an Amphipod, and *Asellus Forelii*, an Isopod closely related to *A. cavaticus*—Prof. Forel maintains that they are descended, not directly from the allied species of the littoral zone, but from the species *N. puteanus* and *A. cavaticus* which inhabit the subterranean waters, and are commonly found in the wells of nearly the whole of Europe. There is no doubt that *A. Forelii* is closely related to *Asellus aquaticus*, nor that *Niphargus puteanus* is equally closely related to *Gammarus pulex;* the question is merely whether the forms at present inhabiting the abysses of the Léman and other lakes are like *Fredericella Duplessis* directly descended, or indirectly descended, from the littoral forms. It was to the first of these views that Prof. Forel formerly inclined: he now gives his support to the second. And mainly for the following reasons. The modifications which *Niphargus puteanus* and *N. Forelii* have undergone are in all important respects the same; they differ at present only in such unimportant points as the number and length of hairs, setæ, and spines. It is unlikely that precisely the same changes would occur under such very different surroundings as those presented by subterranean waters and the deep waters of a lake. Again, *N. Forelii* is not confined to the Léman, and it is improbable that exactly the same variations should have arisen in different localities. And thirdly, since maintaining a lacustrine origin for *N. Forelii* would compel us to admit that it had varied so far from *Gammarus pulex* since the Glacial period, we can by supposing it to have a subterranean origin allow it a far longer time in which to have undergone modification.

"It is more simple, it is more in conformity with facts to admit that the *N. Forelii* of our lake-bottoms is descended from the *N. puteanus* of the underground waters. That is the conclusion to which I adhere. And I extend this same conclusion to *Asellus Forelii*, and seek its origin also in the *A. cavaticus* of the underground waters."

An interesting illustration of the manner in which animals can adapt themselves to their surroundings is to be found in the species of Limnea and in the larvæ of Diptera (Chironomis) which abound in the Léman. In the littoral zone the Limneas, having a pulmonary sac, are air-breathers; in the deep water, without any change of structure, their breathing is aquatic—their pulmonary sac is filled with water. The case of the Dipterous larvæ is more remarkable. We are told that they swarm in the deep water, and that their respiratory apparatus, consisting of tracheæ, is, like the sac of the Limneas, filled with water instead of air. Larvæ abound, but pupæ are very rare, if not altogether absent, and perfect insects are never seen rising from the surface of the deeper parts of the lake; moreover larvæ of all sizes and ages are found on the bottom at the same season. It would appear from the observations of O. Grimm (*Mém. Acad. imp. St. Pet.*, xv. No. 8, 1870), of St. Petersburg, that these larvæ never attain the perfect stage, but are capable of reproduction by *pædogenesis*.

I have no more space; I can only allude to the discovery of two species of Acanthopus, whose nearest relatives are marine Cythæridеæ; to *Plagiostoma Lemani*, also with marine relations; to the remarkable absence in the deep water of Anodon and of Spongilla, both of them so common in the shallows. Let me conclude in Dr. Forel's words:—

"Others may perhaps regret the absence of the strange things which they had expected to meet with in these strange regions. For my part I have had the intense happiness of being the first to penetrate them, I have endeavoured to explain to myself one by one the mysteries which unfolded themselves to my gaze, and I admire and enjoy their harmony and their simplicity above all. Nature is beautiful and great because she is harmonious everywhere and in everything."

G. H. WOLLASTON

THE CRETACEOUS AND TERTIARY FLORAS OF THE UNITED STATES

The Cretaceous and Tertiary Floras of the United States. By Leo Lesquereux. (U.S. Survey of the Territories under F. V. Hayden, Vol. VII.)

AFTER an interval of nearly ten years, Dr. Hayden presents us with further contributions, by Lesquereux, to the Cretaceous and Tertiary floras of the United States. Those principally illustrated are from the Dakota, Laramie, and Green River groups. The author frankly admits at the outset, p. 4, that "the determinations of the plants are still, and must be for a long time to come, unreliable to a certain degree." This admission must be kept in mind in pronouncing on the merits of the book.

The Dakota beds rest on Permian, and contain a Cretaceous fauna associated with a very rich dicotyledonous flora. No one now doubts their Cretaceous age, although they cannot be correlated exactly, bearing in mind the flora, with anything in Europe. It appears from the revision these fossil plants have undergone, that they are much less closely related to existing genera than was previously supposed. Under such circumstances it seems a pity that less compromising generic names were not substituted for those, such as Sassafras, Acer, Quercus, Hedera, &c., as done in the case of Populites. The known flora of Dakota now consists of 5 ferns, 6 Cycads, a dozen Coniferæ, most of them very unsatisfactory, and no less than 162 Dicotyledons, chiefly remarkable for the large number of handsome palmate leaves among them. One of the most interesting genera, because determined from fruits as well as leaves, is Platanus, a genus also common to our own Lower Eocene of Reading, and thus of a high antiquity. Magnolia is another genus adequately determined, but the remainder rest mainly, if not entirely, on the characters furnished by detached leaves. The vexed question of the age of the Laramie or Great Lignitic series of America is again discussed, and a table given of all its species compared with those of Europe, especially the Eocene of Sézanne in the Paris Basin. As a result the author still holds to the opinion that the formation is an Eocene one. A larger part of the work is occupied with descriptions of the Green River plants, chiefly from Florissant, an incredibly rich locality. This is prefaced by a lucid description of the beds, which exceed 300 feet in thickness, by Mr. S. Scudder. They are principally volcanic ash accumulated in one or more old lake-basins. These and most of the other fossiliferous rocks are situated towards the top of the Green River group, which is reckoned to be 2000 feet thick. The flora contains 228 species, of which 152 are from Florissant, and is referred by Lesquereux to the Oligocene. It was originally thought by him to be Miocene, but the detailed comparisons he has made between it and that described by Saporta from Aix, in Provence, prove that he is justified in putting its age further back. Indeed it bears a marvellous resemblance to that of Bournemouth, and had he been able to make comparisons he would perhaps have assigned it a still earlier date. It is a matter of the greatest interest to find in America a flora corresponding to those of Aix and Bournemouth, and not represented anywhere to the north. The last pages are occupied with descriptions of some new Miocene plants from various localities. The book is illustrated by fifty-nine coloured plates, and however we may differ as to the value of the determinations themselves, all will agree as to the great service rendered to science by the publication of such an important mass of data for future comparison. J. STARKIE GARDNER

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Coal-Dust Question

ON several occasions during the last five years, Sir Frederick Abel has referred to the history of the coal-dust question, and to my connection therewith; and as his views on this subject do not altogether correspond with mine, I desire, with your permission, to state in this place how much, and in what particulars, I differ from him.

In his address to the Society of Arts, delivered on the 17th of November last, Sir Frederick says: "Several well-known French mining engineers published, many years after Faraday and Lyell wrote, observations and experimental results as new, which were simply confirmatory of those philosophers' original statements and conclusions, and to some extent this was also the case in still more recent publications in this country by Galloway and Freire-Marreco."

Faraday and Lyell's statements and conclusions were to the following effect:—

1. Fire-damp is not the only fuel in an explosion.

2. The coal-dust is swept up by the blast and is partially burnt.

3. (Speaking of Haswell Colliery explosion)[1] "There is every reason to believe that much coal-gas was made from this dust in the very air itself of the mine, *by the flame of the fire-damp*, which raised and swept it along, and much of the carbon of this dust remained unburnt only for want of air."

That is to say, the flame of the fire-damp is extended, and the effect of the explosion is aggravated by the presence of the coal-dust.

[1] *Phil. Mag.*, 1845.

The Committee of the Coal Trade, who replied to Faraday and Lyell's report in a letter dated February 7, 1845, do not appear to have thought those authors' remarks about coal-dust of sufficient importance to be noticed at all. Nor do the authors themselves seem to have attached any particular importance to them save as a record of a curious physical and chemical fact; for after making them they immediately turned, like all their predecessors and most of their successors, to the contemplation of imaginary magazines of fire-damp as a means of accounting for the explosion. Moreover, both of them lived for many years afterwards, during which one great explosion occurred after another, and yet we do not find that either of them ever lifted so much as the tip of his little finger to point to coal-dust as the probable cause of the catastrophes.

In 1855, M. du Souich, Ingénieur des Mines, said,[1] "A sort of crust of light coke, which could be gathered from the timber at various points, could only have originated from the coal-dust swept up in the working places and carried to a distance by the extremely violent air-current caused by the explosion. This dust being itself partially inflamed *could continue the effects of the fire-damp by carrying them further*" (*peut continuer les effets du grisou en les portant plus loin*).

In 1861,[2] M. du Souich and M. Estaunié again insisted on the same thing in similar terms.

In 1867,[3] M. du Souich again developed the same opinions.

In 1864,[4] Verpilleux de Reydellet, A. Burat, Poumairac Baretta and other engineers emitted opinions similar to the foregoing.

In 1875,[5] M. Vital wrote, "Extremely fine coal-dust is a cause of danger in dry working places in which shot-firing is carried on; in well-ventilated workings it may of itself alone give rise to accidents; in fiery workings it increases the chances of an explosion, and when an accident does occur *it aggravates the consequences of the fire-damp flame*" (*coup de feu*).

In 1875,[6] MM. Desbief and Chansselle gave a short historical *résumé* similar to that of M. Haton, and quoted an opinion of M. Verpilleux which appears to resemble my own, but has never, so far as I am aware, been put prominently forward by the author nor supported by experimental or other proof, namely: "M. Verpilleux, who attaches great importance (*importance capitale*) to coal-dust, was one of the first to call attention to it; comparing a fire-damp explosion to the detonation of a gun, he went so far as to say that the dust represents the powder and the firedamp the priming."

In March, 1875, Sir Frederick, then Professor, Abel, addressing an audience at the Royal Institution on the subject of "Accidental Explosions," referred to explosions in mines, and mentioned the researches that had been made by Mr. R. H. Scott and myself up to that date. He also speaks of dust explosions in flour mills, &c.; but, as showing the small importance he attached to anything that had been previously said or done in regard to coal-dust, it is remarkable that he does not even refer to its existence.

I had been investigating the subject of great colliery explosions since the year 1870, but had been unable to discover any explanation of their occurrence wholly satisfactory to myself. At the commencement of my work I had read all, or nearly all, the English literature connected with it then extant, and amongst other things the report and article of Faraday and Lyell on the Haswell Colliery explosion, and the reply of the Committee of the Coal Trade;[7] but, so little impression did Faraday and Lyell's remarks about coal-dust make upon me at the time, that I afterwards forgot I had read them, and was only reminded of the fact by seeing it recorded in an old note-book of my own some time after the publication of my first paper. I retained the impression, however, for in the paper[8] referred to I wrote: "The accounts of colliery explosions published in this country hardly ever allude to the existence of coal-dust; and when they do so, in one or two cases [it should have been one case only] it is for the purpose of suggesting that the gases disengaged from it by the heat of the fire-damp flame would no doubt be ignited and tend to increase the force of the explosion."

It did not for a moment occur to me that this, which is Faraday and Lyell's view, could ever be accepted as an explanation of the phenomenon I was trying to elucidate.

[1] "Rapport de M. Haton de la Goupillière: Des Moyens propres à prévenir les Explosions du Grisou," 1880.
[2] *Ibid.* [3] *Ibid.* [4] *Ibid*
[5] *Annales des Mines*, 1875.
[6] *Comptes rendus des Réunions mensuelles de Saint Etienne*, June, 1875.
[7] *Iron*, June 1, 1878. [8] *Proc. Roy. Soc.*, 1876.

In the beginning of the year 1875 I removed to South Wales, and soon discovered that all the collieries in which great explosions had occurred were dry and dusty. My previous experience was almost wholly confined to damp mines, in all of which, with one exception (Nitshill), there was no coal-dust, and in none of which, with the same exception, a great explosion had ever occurred. The impression referred to above probably exercised a certain influence at that time in helping me to form the conception of what I believe to be the true explanation of great colliery explosions. In the words of my first paper[1] it is as follows: "If it could be shown that a mixture of air and coal-dust is inflammable at ordinary pressure and temperature, there would be no difficulty in accounting for the extent and violence of many explosions which have occurred in mines in which no large accumulations of fire-damp were known to exist; for it is only necessary to suppose that a violent gust of wind (originated, for example, by the explosion of a small accumulation of fire-damp) had swept through the adjoining galleries, raising a cloud of dust into the air, and then all the other phenomena would follow in regular order. The flame of the originally inflammable mixture would pass into the newly-formed one, expanding its volume; the disturbance would be propagated over an ever-widening area, until that area might possibly become co-extensive with the workings themselves; and *the consequences would be the same as if the whole space had been filled with an inflammable mixture before the disturbance began.*"

I demonstrated by an experiment first made on the 3rd of July, 1875, that air containing less fire-damp than can be detected by the ordinary means of testing the air in mines, is rendered inflammable at ordinary pressure and temperature when fine dry coal-dust is added to it. This was the first step towards proving the truth of my theory.

In the same paper I also stated, "It is always possible that if coal-dust could be made fine enough and were thoroughly mixed with dry air in the proportion of about 1 pound to 160 cubic feet of air, the mixture might be inflammable at ordinary temperature, or, *if not*, it might at least be so nearly inflammable that an explosion begun in it, in a confined space, might be propagated through it."

In my second (1879) and subsequent papers to the Royal Society, I stated the further opinion, first, as the result of more elaborate experiments, and secondly, as the result of a careful personal investigation and consideration of all the circumstances attending the occurrence of several great explosions, that, "A fire-damp explosion occurring in a dry coal-mine is liable to be indefinitely extended by the mixture of air and coal-dust produced by the disturbance which it initiates." This was the final step.

Of this, Sir Frederick says:[2] "Mr. Galloway was certainly the first to enunciate the conclusion that a small proportion of fire-damp is essential to impart to a mixture of air and coal-dust the power of propagating flame, though *he afterwards abandoned this conclusion in favour of the one some time previously accepted by Marreco*, to the effect that fire-damp is altogether unnecessary for the conveyance of flame with explosive effect by a mixture of dry coal-dust and air."

In January, 1878, I commenced a series of articles in *Iron* on coal-dust explosions, hoping thereby to arouse an interest in the subject, and, amongst other items of information, I gave translations of Vital's and Desbief and Chanselle's papers. Seven of these articles had already appeared when, in April, 1878, Prof. Marreco (to whom I had myself sent copies of them) and Mr. Morison, read their first paper before the Chesterfield Institute. They say, "Before the writers had the opportunity of learning what had already been accomplished abroad, their attention was directed to the subject by a paper read by Mr. W. Galloway before the Royal Society, in which he related his experiment in producing explosion in a mixture of fire-damp and air impregnated with dust. The opinion expressed in that paper, viz., that coal-dust was explosive only in an atmosphere containing a minute proportion of fire-damp, induced the writers to still further extend the scope of the experiments, and endeavour to discover whether coal-dust could by any means be exploded in an atmosphere totally free from fire-damp."

The arrangement to carry out the experiments here spoken of was made between Marreco and myself in the end of 1875 or beginning of 1876, and was referred to in my first paper (1876) thus: "It would be premature to draw any positive inference from my experiments with gunpowder shots, as they are by no means so satisfactory as I could wish, and I am glad to be able to state that Prof. Marreco, of Newcastle-on-Tyne, intends to investigate this question with more substantial apparatus."

Returning to Sir Frederick's remark, I would say that I abandoned no previous conclusion "in favour of one some time previously accepted by Marreco." I then held, and still hold, what is now a universally accepted opinion amongst mining men, that a mixture of air and fire-damp, which is not inflammable at ordinary pressure and temperature, may be rendered inflammable by the addition of dry coal-dust, and I was prepared, as soon as proof satisfactory to myself was forthcoming, to extend the area of my opinion, so as to include a mixture of fine dry coal-dust and air in the same category. This latter proof alone was necessary to the firm establishment of the theory enunciated at the commencement of my first paper, and for that reason Sir Frederick's statement appears to me to be wanting in logical sequence.

Neither the statement made by Marreco and Morison, that they intended to "endeavour to discover whether coal-dust could by any means be exploded in an atmosphere totally free from fire-damp," nor the results of the experiments published by them, appear to me to warrant Sir Frederick in taking up this position; for, concerning these very experiments of Prof. Marreco's he had himself remarked in the year 1880:[1] "It does *not appear that* in the numerous experiments made at Harton Colliery by the exposure of naked flames in currents of air laden with coal-dust, and by firing small cannon (representing blown-out shots) placed in various positions in such air-currents, *any indication has been obtained of a propagation of flame by the coal-dust.*" How then could Marreco have concluded that "fire-damp is altogether unnecessary for the conveyance of flame with explosive effect in a mixture of coal-dust and air"?

Sir Frederick continues to say, regarding myself: "Even his latest publication on the subject tends in the same direction, and emphasises his desire to 'claim that no earlier author had gone the length of crediting coal-dust with the *rôle* of principal agent, and relegating fire-damp to a secondary position.' The more recent results of other writers in this direction have, however, conclusively demonstrated that this is far too great a length to go, and that while on the one hand a very fine dry and highly inflammable coal-dust may, when raised and mixed with air by the force of a blown-out shot, become inflamed, and may then carry flame to considerable distances with a rapidity and violence of action similar to that of a fire-damp explosion, the extent to which, on the other hand, flame is propagated under corresponding conditions by most descriptions of coal-dust in the complete absence of fire-damp is very limited."

Sir Frederick and those whose opinions he here quotes appear to have omitted to take one element into consideration which has an important bearing upon the case. To this I may have occasion to refer more particularly at an early date.

W. GALLOWAY

Sunset-Glows

I WISH to call the attention of observers to a peculiar phenomenon which has been frequently noticed by me lately in connection with these sky-scenes. A very bright after-glow was visible here on October 27 last. I believe the date is correct, although I have unfortunately mislaid my day-book; the facts, however, I can vouch for otherwise, as they were detailed at the time. At 5 p.m. a heavy bank of cumulus was to be seen extending along the south-western sky-line, about 5° above and closely parallel to the horizon. High over this bluish bank of cloud rose the yellow haze of departing sunlight. This diffused after-glow was plainly intersected by numerous (I counted twenty-two) delicate streaks of nebulous stratus. These intersecting lines (they were scarcely "bands") were horizontal and parallel, piled up, as it were, above one another as high as 25° from the sea-line. The lowest hung apparently about half a degree above the gilded upper edge of the dark cumulus. On November 4, just before sunset, I exposed a gelatine plate, and succeeded in obtaining a photograph, in which seven of these narrow horizontal cloud-streaks can be faintly seen. On December 1 the following note was made:—4.20 p.m. Wind light,

[1] *Proc. Roy. Soc.*, 1876.
[2] *Journal Soc. Arts* No. 20, 1885, p. 23.

[1] "Report on the Results of Experiments made with Samples of Dust collected at Seaham Colliery, &c.," 1880.

N.N.W. Sunset-glow intersected by five horizontal dark cloud-streaks in the west. On the 2nd inst., at 4.20 p.m., five cumulo-strati were visible in the west, separated by parallel and horizontal orange-coloured bands. Above these were numerous (probably twenty) delicate dark lines traversing—also horizontally—the upper roseate after-glow. On the 10th and 11th inst., somewhat similar phenomena were visible here. On the 15th inst., with a light southerly air, eleven cloud-bands were seen by me at 4.30 p.m. In this case only, they were not parallel to the sea-line, but followed the direction of the west-north-west horizon. I have seen the same appearances once or twice since the last date. The above phenomena are new to me, and I have not met with any detailed account of them elsewhere. I have therefore ventured to address you on the subject. Can these cloud-streaks represent stratified air-dust in the upper regions of our atmosphere? W. AINSLIE HOLLIS

Hove, Brighton, December 26

Iridescent Clouds

THERE was a very striking display of iridescent clouds this afternoon. I noticed it first at about 3.40 p.m. The prismatic colours were pretty strongly marked, and the intense pearly brilliance of the delicate cirri was most striking. It is still visible (4.40 p.m.), though, of course, its lustre is much diminished. A gale is blowing from the west, and there has been an orange after-glow. Similar phenomena were described in your columns about this time last year. They were well seen in this part of the country. EDWARD GREENHOW

Earsdon, Newcastle-on-Tyne, December 28

YESTERDAY, clouds very similar to those seen a year ago made their appearance, and there were a few of them again this morning. I first noticed them at 11.30 a.m., and they were extremely magnificent after sunset, showing three or four spectra of colour, and they were especially striking about 4.10 p.m., when they appeared very bright against the purple glow of the sky. Their chief difference from the clouds last December was that they were not bounded by straight lines, and that there was no special amount of blue in the colouring, as was usually the case a year ago. The chief colours were pink and green.

Sunderland, December 29 T. W. BACKHOUSE

Ventilation

IN reply to the query of J. F. Tennant, there can be no doubt that the cause of the failure of the ceiling ventilators is a deficiency of fresh-air supply to the room. An ordinary chimney with a fire will, if unchecked, draw an amount of cold air into the room which would make the temperature about the same as that of the outside air, and without enormous volumes of warmed air it is, I think, impossible to expect any service whatever from the system of ventilation from ceiling-flues, as recommended by the writer of the article referred to. Since writing my first letter I have seen a regenerator lamp attached to one of these ceiling-flues, and the down-draught was so strong and persistent as to reverse the natural current of the lamp, rendering its use impossible. The air-inlet to my own rooms consists of a channel in the wall of every room opening into ten one-inch holes at the fireplace, but this, of course, is utterly inadequate to supply one-tenth of the air required by the flue, and the ventilator and the ventilating-shaft supplement this supply by working the wrong way. THOS. FLETCHER

Warrington

A VERY common source of trouble with respect to ventilation is the absence of any arrangement for the supply of air to fires. So long as a fire draws on the general atmosphere of the room it is supposed to warm for its supply of oxygen, there must be the "draughts" so often complained of, and people are warm on the side next the fire, and cold on the other. I should suppose this is what happens in Mr. Fletcher's case, described in his letter in NATURE (pp. 153-4). If so, there is simply a sort of "tug-of-war" between the longer chimney-flue and the shorter ventilation flue, with the additional advantage on the side of the former that the column of air ascending the chimney is necessarily much warmer than that which should ascend the ventilation flue. If, however, Mr. Fletcher will have a couple of holes bored in his floor, one on each side of the fireplace, so as to supply air directly to the fire, the "pull" of the fire on the air of the room will cease, the room will be warmer, and his ventilation flue should work satisfactorily. I warm thoroughly a room with considerably over 2000 square feet of floor area by means of three small stoves. When first used the stoves were inefficient, as there was a draught all round each towards it. A common rain-water pipe "bend," inserted in the floor immediately in front of the aperture of each stove for admitting the air-supply, stopped the draughts, and at least doubled the efficiency of the stoves as warmers. With the help of Tobin tubes there is now a gentle current of warmer air *from* each stove. The heated and vitiated air escapes through ventilators fixed in the ridge of the roof. W. WILKINSON

Eldon, Bishop Auckland, December 23

Friction and Molecular Structure

IN your number of December 17 (p. 154) is a letter signed by Mr. E. Geoghegan, referring to the effect of moderate friction on the molecular structure of glass lamp-chimneys. This I have very frequently observed, and it would be very interesting to have suggestions as to its cause and means of prevention. I often read under one of Sugg's Argand gas-burners, the chimney of which almost invariably breaks on first heating after cleaning. First of all, washing was tried, to remove the mottled milky stain which forms on the glass, and then rubbing with a silk cloth or cotton rubber, but there does not seem to be much difference in the result, as the glasses, the best I can obtain, generally break. C. K. BUSHE

Bramhope, Old Charlton, Kent, December 25

The Longevity of Insects

WITH reference to the longevity of insects, it is worth while to record that we kept a ladybird from the September of one year to the September of the following. She was a handsome specimen of the seven-spotted ladybird, and her eggs, which were laid in the winter, after passing through the miniature crocodile stage, produced perfect insects in February. It is curious to watch the imago emerging from its dusky case; at first no spots are visible on its buttercup-yellow "shards," which contrast strongly with the jet-black legs and underneath; but in a very few hours the first brilliancy has gone, the spots appear faintly, and in a few days the final red with the black spots is established. E.

December 28

SOUTH AMERICAN BIRD-MUSIC

MR. BURROUGHS, an American naturalist, in his "Impressions of some British Song Birds," has said:—"Many of the American songsters are shy wood-birds, seldom seen or heard near the habitations of men, while nearly all the British birds are semi-domesticated, and sing in the garden and orchard. This fact, I had said, in connection with their more soft and plaintive voices, made our song-birds seem less to a foreign traveller than his own." These words apply with much greater force to the birds of South America, the species being much more numerous and less well known than in the northern portion of the continent; while the true songsters are relatively fewer, owing to the presence of several large songless families, such as the tyrants, humming-birds, and others.

The South American songsters certainly do not, like those of Europe, mass themselves about the habitations of men, to sing there as if sweet voices were given to them solely for the delectation of human listeners; they are pre-eminently birds of the wild forest, the marsh, and the savannah; and the ornithologist or collector from Europe, whose principal object is to make a large collection, has little time to make himself acquainted with the accomplishments of the species he desires above all things to shoot. Nor is this all. Doubtless there remains in the minds of most people something of that ancient notion that brilliant-plumaged birds utter only harsh, disagreeable sounds; while the sober-toned songsters of temperate regions—especially those of Europe—have the gift of melody; that sweet songs are heard in England, and screams and grating notes within the tropics. Only we know now that the obscure species there are greatly in excess of the brilliant ones. It is quite possible, however, that the tropics, so rich in other respects, though by no means the realms "where birds forget to sing," do not excel, or even equal, the temperate regions in the amount and quality of their bird melody. Mr. im Thurn only echoes the words of many English travellers in the tropics, when he says, in his recent work on British Guiana:—"The almost entire absence of sweet bird-notes at once strikes the traveller who comes from thrush and warbler-haunted temperate lands." Mr. Bates, on this subject, says:—"The few sounds of birds are of that pensive and mysterious character which intensifies the feeling of solitude rather than imparts a sense of life and cheerfulness."

On the question of tropical bird-music much remains to be said by future travellers; but South America is not all tropical, and travellers visiting the southern temperate portion of that continent might have looked to find there melodists equal to those of Europe and North America; for even assuming that to utter agreeable sounds a bird, wherever found, must be fashioned after the pattern of some European form, we find that the typical songsters of the north—the thrushes, wrens, warblers, finches, &c.—are well represented in the Plata, Chilian, and Patagonian regions. As a fact, the best songsters there belong to the wide-ranging American genus *Mimus*, while in the more tropical Icterine family there is great variety of language, and some exceedingly sweet voices.

Of the great naturalists of recent times who have depreciated South American bird-music, I will mention Darwin only, as very great importance must always be attached to his words, even when he fails to show his usual discrimination. He says of the common *Mimus calandria*:—"It is remarkable from possessing a song far superior to that of any other bird in the country; indeed, it is nearly the only bird in South America which I have observed to take its stand for the purpose of singing." He then adds that the song is like that of the sedge warbler.

There are many better singers than the *M. calandria*; and as to its being nearly the only bird that takes its stand for the purpose of singing, there are, in the Plata district alone, a greater number of birds with that habit than in England; though, taking the number of species in the two countries, the Plata singers are relatively fewer. It is equally beside the mark to compare the sedge warbler with the Calandria, the performance of the former bird resembling that of the other only as a slight sketch may be said to resemble a finished painting.

Darwin does not say much about the singing of birds, and appears to have taken but little interest in the subject, possibly because this species of natural melody gave him little or no pleasure; otherwise he could scarcely have written of the Diuca Finch that "the male during incubation has two or three pleasant notes, which Molina, in an exaggerated description, has called a fine song." The fact is, the old Chilian naturalist scarcely does justice to the song of the Diuca, which is mellower in sound than any other finch-melody I am acquainted with. Of his account of the singing of the Thenca mocking-bird, the Thili, the black-headed finch, Loyca, and various other species, Darwin says nothing.

Not all the European writers whose words carry weight, however, have turned a deaf, or, at any rate, a very unappreciative ear to the bird-music of the great bird-continent. Azara is a notable exception. He was not a mere collector, nor was he even a naturalist in the strictest sense of the word; but, made fit for his task by a keen faculty of observation, and an insatiable craving for knowledge of all kinds, he went into the forest to watch the birds and write the history of their lives. In Spain he had been familiar from childhood with the best songsters of Europe, and in Paraguay he paid great attention to the language of the species he noticed. He makes mistakes sometimes, when speaking of the nesting or other habits, but when describing their songs, he records his own impressions only. With the works of his contemporary, Buffon, he only became acquainted after having completed his own observations; and the voluminous strictures on the French naturalist, which burden, and to some extent spoil, the otherwise delightful "Apuntamientos," were only inserted after his own descriptions had been written.

In his introductory pages, entitled "De los Paxaros en General," he refers to Buffon's well-known opinion concerning the inferiority of American songsters, and says:—"But if a choir of singers were selected in the Old World, and compared with one of an equal number gathered in Paraguay, I am not sure which would win the victory." In another place, in allusion to the same subject, he says:—"They are mistaken who think there are not as many and as good singers here as in Europe."

To return for a moment to Mr. Bates's words, already quoted, bird-music of that "pensive and mysterious" character he mentions is to many minds more pleasing than the loud, cheerful, persistent singing of many highly-esteemed British singers, like the chaffinch and song-thrush.

Mr. Bates also heard in the Amazonian forest, "another bird that had a most sweet and melancholy song, uttered in a plaintive key, commencing high, and descending by harmonic intervals."

Of the common house-wren of the Plata, Azara says that its song is "in style comparable to that of the nightingale, though its phrases are not so delicate and expressive; nevertheless, I count it amongst the first songsters." He speaks even more highly of the voice of the Todo Voz (*Cistothorus platensis*), which greatly delighted him with its sweet, varied, and expressive melody. The members of this melodious genus, and of the allied genera, are found throughout South America, from Panama to Patagonia, and we know from others besides Azara that their music does not dissolve away in the tropics, or turn to harsh sounds. Mr. Wallace heard a Cistothorus singing very sweetly on the shores of the Amazon, and D'Orbigny, in the "Voyage dans l'Amérique Méridionale," thus describes the singing of the *Thryothorus modulator*, which he heard in Yungas, in Bolivia:—"Perched on a bough overhanging the torrent, its rich melodious voice seemed in strange contrast to the melancholy aspect of its surroundings. Its voice, which is not comparable with anything we have in Europe, exceeds that of the nightingale in volume and expression, if not in flexibility. Frequently it sounds like a melody rendered by a flute at a great distance; at other times its sweet and varied cadences are mingled with clear piercing tones or deep throat-notes,—in one word, a grave music composed of the purest sounds. We have really no words adequate to express the effect of this song, heard in the midst of a nature so redundant, and of mountain scenery so wild and savage."

It might be thought that in this description allowance must be made for the enthusiasm natural to a Frenchman, but Mr. Bates, certainly the most sober-minded naturalist that ever penetrated the Brazilian forests, gives a scarcely less fascinating account of a melodist closely allied to D'Orbigny's bird, if not identical with it. "I frequently heard," he says, "in the neighbourhood of these huts the realejo or organ-bird (*Cyphorhinus* *cantans*), the most remarkable songster by far of the Amazonian forest. When its singular notes strike the ear for the first time the impression cannot be resisted that they are produced by a human voice. Some musical boy must be gathering fruits in the thickets, and is singing a few notes to cheer himself. The tones become more fluty and plaintive; they are now those of a flageolet, and, notwithstanding the utter impossibility of the thing, one is for the moment convinced that some one is playing that instrument. . . . It is the only songster which makes an impression on the natives, who sometimes rest their paddles whilst travelling in their small canoes, along the shady by-paths, as if struck by the mysterious sound."

Outside of these pre-eminently tuneful groups—thrushes, warblers, finches, &c.—there are many species belonging to groups considered songless which nevertheless do sing, or have, at any rate, some highly musical notes. Dendrocolaptine birds are not, strictly speaking, songsters; but they are loquacious, and fill the woods with sound, often pleasant and laughter-like in character; and in many species the male and female combine their voices in a pretty kind of chorus. In the well-known oven-bird this is very striking, the male and female singing a ringing joyous duet in different tones, producing an harmonious effect. D'Orbigny notices this harmonious singing of the *Furnarius*. The hirundines in many cases have voices utterly unlike those of Europe, which as a rule only emit a squeaking twitter. They have, on the contrary, rather thick tones, in many cases resembling the throat-notes of the skylark, and some have a very pleasing set song. The human-like tones of some of the pigeons, the plaintive fluting of the Tinamous, even the notes of some kingfishers and cuckoos, contribute not a little to the bird-music of South America. Waterton's words about the "songless" bell-bird are well known, and, allowing that he goes too far when he says that Orpheus himself would drop his lyre to listen to this romantic sound, it is still certain that there are hundreds of species, which, like the bell-bird of the Orinoco forests, utter a few delightful notes, or produce a pleasing effect by joining their voices in a chorus. Thus, Mr. Bates speaks of the *Monasa nigrofrons*—a barbet:—"This flock of Tamburi-para were the reverse of dull: they were gamboling and chasing each other amongst the branches. As they sported about they emitted a few short tuneful notes, which altogether produced a ringing musical chorus that greatly surprised me."

But even leaving out all these irregular melodists; also omitting the tanagers, the tyrants, and their nearest allies; the Dendrocolaptidæ and Formicaridæ, and the humming-birds—these few families I have mentioned comprising about 1800 species—there would still be a far greater number of regular songsters than Europe can show, so great is the bird-wealth of South America; and concerning the merits of their music I can only say that Azara and D'Orbigny did not hear the best singer—the *Mimus triurus*. It would have been strange indeed if in that portion of the globe, so inconceivably rich in species, and where bird-life has had its greatest development, the faculty of melody had not been as highly perfected as in other regions.

A very long time has passed since Azara made that remark about a choir of song-birds selected in Paraguay, and our knowledge on this subject—possibly because it has been thought unimportant—has scarcely been added to since his day; but it seems to me that when the best singers of two regions have been compared, and a verdict arrived at, something more remains to be said. The species which "formally take their stand for the purpose of singing" sometimes delight us less than others which have no set song, but yet utter notes of exquisite purity. Nor is this all. To most minds the dulcet strains of a few favoured songsters contribute only a part, and not always the largest part, of the pleasurable sensations received from the bird-voices of any district. All natural sounds produce, in some measure, agreeable sensations: the pattering of rain on the leaves, the lowing of cattle, the dash of waves on the beach, the "springs and dying gales" of a breeze in the pines; and so, coming to birds, the clear piercing tones of the sandpiper, the cry, etherealised by distance, of a passing migrant, the cawing of rooks on the tree-tops, afford as much pleasure as the whistle of the blackbird. There is a charm in the infinite variety of bird-language heard in a sub-tropical forest, where birds are most abundant, exceeding that of many monotonously melodious voices; the listener would not willingly lose any of the many indescribable sounds emitted by the smaller species, or the screams and human-like calls, or solemn, deep booming or drumming of the larger kinds, or even the piercing shrieks which may be heard miles away. The bird-language of an English wood or orchard, made up in most part of melodious tones, may be compared to a band composed entirely of small wind-instruments with a very limited range of sound, and which produces no storms of noise, eccentric flights, or violent contrasts, or anything to startle the listener—a sweet but somewhat tame performance. The sub-tropical forest is more like an orchestra in which a countless number of varied instruments take part in a performance in which there are many noisy discords, while the tender, spiritual tones heard at intervals seem, by contrast, infinitely sweet and precious.

W. H. HUDSON

FORESTRY

THE report of the proceedings of the Select Committee on Forestry which sat during the past summer does not, perhaps, throw any more light on the condition of forestry in this country than was possessed before the appointment of the Committee, for the substance of the evidence given is for the most part to be found in the various works and reports on forestry that have appeared from time to time during the past few years; nevertheless the evidence of such men so well versed in forest conservancy, especially with regard to India, as Dr. Cleghorn, Col. Michael, Col. Pearson, and Mr. W. G. Pedder is of much value, as it brings together in a collected form information that has hitherto been much scattered.

The subject of forest produce is one that is but little understood or even thought of by people in general. It is supposed by most people to relate only to the supply of timber, which indeed of itself is of very great importance; but when we consider the other products—such as gums, resins, oils, fibres, and such like—the enormous money value becomes more apparent, as well as the great importance of the forests as sources of many absolute necessities of life. The evidence of Col. Michael fully illustrates this and is especially valuable from this point of view. Taking the subject of Indian timbers alone, the value of teak was fully set forth when it was shown to be unequalled for the backing of ironclads and for shipbuilding generally, as offering the greatest resistance of any known woods. Questioned as to whether teak was capable of being brought into this country as a commercial article at a remunerative profit, Col. Michael replied that, judging from the price realised for some logs sold at the Forestry Exhibition at Edinburgh and from other information obtained, no doubt existed that the trade in teak might become a very remunerative one. It was shown further that in 1883 647,000*l*. worth of teak was imported into England; but Col. Michael also touched upon what, if put upon a proper footing, might equally, or perhaps more so, become a source of revenue to India and a boon to this country—namely, the introduction of the more ornamental woods for cabinet purposes. There is, of course, always a steady demand for British-grown timbers such as oak, elm, ash, maple, &c., but these have to be supplemented by foreign woods of a more ornamental character, and of these mahogany, rosewood, ebony, satinwood, and such like are the best known. From amongst Indian timber trees a long list might be made of woods which are now almost unknown out of their native country—such, for instance, as the East Indian cedar (*Cedrela toona*), which is a reddish-coloured wood with a splendid wavy or feathery figure; the tree is also found in Australia, where the wood is highly valued; the padouk (*Pterocarpus indicus*), the deep-red-coloured wood of which attracted so much attention at the Edinburgh Exhibition last year; the Malabar Kino tree (*Pterocarpus marsupium*), also a finely-marked deep-red wood, several species of *Terminalia*, durable woods of a brown colour with darker brown markings. Many others might be mentioned, but the most beautiful of all the Indian woods for its ornamental character is the Chittagong wood (*Chickrassia tabularis*). This is of a brown colour, with transverse lighter silvery-brown wavy markings, which impart to it a varying depth of light and shade, which, when polished, imparts a peculiar and charming lustre. All these woods take a high polish, and would be invaluable for cabinet-work. Fine specimens of these and many others are in the collection of Indian timbers exhibited in the No. 3 Museum at Kew.

On the question as to the durability of the Scotch fir (*Pinus sylvestris*) Col. Pearson gave an opinion which is worth quoting. He says:—"I think myself that as the value of the foreign imported timber increases, as it must do as the quantity diminishes, people will come to appreciate more the Scotch fir, because I know many barns which have been boarded with Scotch fir for twenty years, and which are standing perfectly well: but it is convenient to get the imported boards ready sawn out, and where the people can get them cheap they do not pay attention to the Scotch and home-grown timber. But, speaking for myself, I should say that Scotch fir is a perfectly good wood as long as it is sufficiently mature, and I think, as foreign wood becomes dearer, as it will in a few years, English timber and Scotch timber will become of a value which it has not now."

On the general subject of the proposed Forest School Col. Pearson expressed himself in favour of a Chair of Forestry at the Edinburgh University, but he further stated that he had no actual faith in lectures in the school unless illustrated by practical instruction. "If," he says, "you tell a man in the lecture room that such and such consequences will take place, and do not show him the consequences on the spot, he does not believe anything about it; it goes in at one ear and out at the other; he will think it all nonsense; but if you want to impress your teaching upon him, you must take him out into the forests and show him the operations of Nature." Regarding the extent or scope of the School, Mr. Thiselton Dyer, in reply to Sir Edmund Lechmere whether he would not make the School of Forestry applicable to India and the Colonies as well as to our own country, said, "I should like to get all the fish possible into the net, and if we had such a school, to make it as useful as possible. I think it is surprising, considering how large is the interest of the English race in forestry, that except in India we have taken no kind of active interest in the subject: although we own more forests in the world than any other race, we are at present, except in the most piecemeal fashion, absolutely washing our hands of the whole business." Mr. Dyer, in his evidence, further pointed out by way of illustration a few of what are usually called the minor industries of forest produce, which in the aggregate become of considerable national importance.

It is to be regretted that the Committee was not nominated at an earlier period of the session. The first sitting was on July 14, and at the two subsequent sittings on July 21 and 24, witnesses only were examined. The report of the Committee refers to the impossibility of concluding their investigations during the Session, and "recommends that a Committee on the same subject should be appointed in the next Session of Parliament."

JOHN R. JACKSON

OBSERVATIONS ON THE RECENT CALCAREOUS FORMATIONS OF THE SOLOMON GROUP, MADE DURING 1882-84[1]

ON account of the treacherous character of the natives of the Solomon Group, no extensive geological observations have ever been made in these islands from the period of their discovery by the Spaniards three centuries ago. For this reason my excursions in these regions were not free from personal risk; in many places they were considerably curtailed, and in some islands they had to be abandoned altogether.

This archipelago includes seven or eight large islands, some of which are from seventy to eighty miles in length, and the highest from 8000 to 10,000 feet in height. Besides these, there are a great number of smaller islands and islets, some of volcanic and others of recent calcareous formations. Restricting my remarks to those islands which are wholly or in part composed of these calcareous rocks, I may observe that, although only able to become acquainted with a small portion of the Solomon Group, the islands which I examined represent the different types of islands that there exist.

In this, the largest of the Pacific groups, I not only found existing fringing-reefs, barrier-reefs, and atolls, but I discovered pre-existing reefs of these three chief classes which have been recently elevated to a height often of several hundred feet above the sea. My observations on these recently-elevated reefs and their foundations have enabled me to approach the problem of the formation of coral reefs by the inductive rather than by the *a priori* method: for it is evident that in passing from the consideration of a probable cause of the formation of existing reefs to the examination of ancient reefs that have been raised with their foundations above the sea, we enter a domain of greater certainty. I purpose in this abstract to state concisely the principal characters of the islands which are wholly or in part of calcareous formations; then to draw four limited inferences from these facts of observation without reference to any particular views that may be held on the subject of the origin of coral reefs; and finally to compare such conclusions with the prevailing views on that subject.

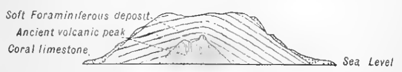
In the first place there are numerous small islands and islets less than a hundred feet in height, which are composed in mass of coral limestone. Of this class Stirling Island may be taken as an example. In the bold cliffs, which form the weather coast of this small island, there are numerous imbedded masses of the reef-building corals, many of them measuring four feet across, the majority of them in the position of growth, but some of them inverted.

The island of Ugi, which is six miles in length and about 500 feet in height, may be taken as a type of the next class. Its geological structure may be briefly described as composed in bulk of a soft earthy bedded deposit, possessing the characters of the "volcanic muds" of the *Challenger* soundings, containing numerous Foraminifera, and encrusted near the coast by coral limestone, which almost disappears in the higher regions. The greatest thickness of the coral limestone that I found in this island was between 90 and 100 feet. As one ascends the higher slopes of the island the coral limestone thins away, and

[1] By H. B. Guppy, M.B., F.G.S., late Surgeon of H.M.S. *Lark*. [Abstract of a paper read before the Royal Society of Edinburgh, on June 15th, 1885, being communicated by Mr. John Murray.]

only occasional fragments occur in the red argillaceous soil. The greatest elevation at which I found the coral rock was about 425 feet above the sea. The soft Foraminiferous deposit, which forms the mass of the island, is regularly bedded, the dip varying usually between 10° and 15°, but it may rise to as much as 35°. Entire shells are rarely found in these beds, the Foraminiferous tests being usually the only organic remains visible to the naked eye.

The island of Treasury affords an example of the next type of island. It is oval in shape, has a length of nine miles, and rises about 1150 feet above the sea. Here we have exposed the nucleus of volcanic rock which has been covered over by soft bedded deposits that resemble, like those of Ugi, the muds found in the *Challenger* Expedition to be at present forming around oceanic volcanic islands, whilst the coral limestone only attains any thickness near the coast, and is wanting altogether in the higher regions of the island. At elevations exceeding 400 feet above the sea the coral rock generally disappears from the surface. Above this height it is only found occasionally, 900 feet being the greatest elevation at which I found a fragment. The thickness of the coral limestone does not exceed 100 feet. The soft deposit, which is regularly bedded, the dip varying between 10° and 30°, displays a greater variety in its characters than the similar deposit in the island of Ugi. As a rule it presents to the naked eye no other conspicuous organic remains than the white specks of the more minute Foraminiferous tests and the larger microscopic tests of such species as *Cristellaria calcar*, *C. mamilligera*, and others; but in some localities this deposit becomes highly fossiliferous, when it assumes a more compact texture, and displays to the eye fragments of corals with Pteropod and Lamellibranchiate shells. As shown in the accompanying diagram, the structural history



Ideal section of an island displaying the originally-submerged volcanic peak, the overlying soft deposits, and the encrusting coral limestone.

of this island of Treasury may be readily inferred. An ancient submerged volcanic peak, having been covered by a thickness of some hundreds of feet of deposits, for the most part resembling the muds now being formed around volcanic islands, has by this means and by the movement of elevation been brought up to the zone of reef-building corals. After the coral reefs had become established, the whole structure experienced an upheaval of nearly 1200 feet.

In the island of Alu, the principal of the Shortland Islands, another type of structure is exhibited. This island, which has a breadth of eleven or twelve miles and an elevation of about 500 feet, is composed in its north-west portion of ancient and originally deep-seated volcanic rocks (mostly quartz-diorites), while the greater part of it, together with the off-lying lesser islands and islets, is made up of more recent calcareous formations. In describing its structural history I shall be describing its structure. We have the original land of volcanic formation in the north-west part of the island, from which, as from a neucleus, line after line of barrier-reef has been advanced in a south-easterly direction based on a foundation of Pteropod and Foraminiferous muds, and forming ultimately, as the upheaving movement continued, the large island of Alu, which yet preserves in the ridges of its interior these ancient barrier-reefs now removed far from the coast and elevated some hundreds of feet above the present sea-level. The soft deposit underlying the elevated reef-masses contains in abundance the shells of Pteropods and bivalves, the otoliths of fish, the tests of pelagic and bottom-living Foraminifera, and some simple corals of deep-sea genera. The overlying coral limestone sometimes assumes a chalk-like character, and in the interior of the island it may give place to a Foraminiferal limestone. The characters of these different rocks are described in the second part of this paper. The thickness of the coral limestones in this island is probably under 100 feet. When it caps the upraised island barrier-reefs it does not exceed forty feet; but these regions have been subjected to great denudation.

In the small island of Santa Anna, which is two and a half miles in length, we have an upraised atoll that displays within the small compass of a height of 470 feet the several stages of its growth. There is, in the first place, the originally submerged volcanic peak; then the investing soft deposit which, according to Mr. Murray, has the characters of a deep-sea clay; and over all the ring of coral limestone that cannot far exceed 150 feet in thickness. The interior of this upraised atoll is a closed basin containing a fresh-water lake, the bottom of which lies about a hundred feet below the present sea-level: so the island may be roughly compared to a bowl of fresh water floating on the sea. In the vicinity of the locality where the deep-sea clay was exposed, Lieut. Malan observed a concretionary block of manganese peroxide between one and two cubic feet in size, which, according to Mr. Murray, who examined a typical fragment, is quite similar in characters to the smaller masses obtained in deep-sea soundings. The structural history of this island may be briefly summed up. A submarine volcanic peak, having been invested by a deep-sea clay, was brought up by upheaval to the coral zone. An atoll was established on it, and the whole was subsequently raised to a height of nearly 500 feet above the sea.

Lastly, I come to the large mountainous islands, of which St. Christoval may be taken as the type. This island is more than seventy miles in length, and about 4100 feet in height. It is composed in mass of ancient volcanic rocks, which are flanked on their lower slopes by recent calcareous formations. A fawn-coloured crystalline limestone, containing reef débris, lies directly on the volcanic rock, and is itself overlain by the coral limestone. I did not find these calcareous rocks above 500 feet above the sea; so great has been the denudation of this island that these calcareous formations constitute a much thinner crust than that which came under my notice in the smaller and more recent islands.

Such being the facts, I come now to the four general conclusions, which are as follows:—

1. *That these upraised reef masses, whether atoll, barrier-reef, or fringing-reef, were formed in a region of elevation.*

This is self-evident. The last upheaval that occurred, of which I found proofs in different parts of the group, was to the extent of about five feet; but at the present day there are signs of this movement being still in operation, and, for the purposes of future observation, I have established datum-marks in different islands. This, therefore, being a region of elevation, it is apparent that that portion of Mr. Darwin's theory of coral reefs which ascribes the formation of atolls and barrier-reefs to a movement of subsidence cannot be applied to the islands of the Solomon Group, since we here find upraised atolls and barrier-reefs associated with existing reefs of the same description. This conclusion accords with the results obtained by Prof. Semper in the case of the Pelew Islands, and by Prof. A. Agassiz in the case of the Florida reefs.

2. *That such upraised reefs are of moderate thickness, their vertical measurement not exceeding the limit of depth of the reef-coral zone.* Amongst the numerous islands which I examined I never found one that exhibited a greater thickness of coral limestone than 150 feet, or 200 feet at the very outside. In fact, so great has been the denudation of these islands, where, according to my own

observations, there is an annual rainfall at the coast of 150 inches, that I rarely came upon a thickness of a hundred feet of coral limestone. One of the corollaries of the theory of subsidence is concerned with the great thickness of atolls and barrier-reefs. My observations in this region—and it is such regions that can alone afford such evidence—show that atolls and barrier-reefs can be formed with no greater thickness than they would possess in accordance with the depths in which reef-corals thrive, the vertical thickness of the reef not exceeding the depth of the reef-coral zone. . . . The only objection worthy of attention that had been advanced against the atoll-theory of Mr. Darwin was, in the opinion of Sir Charles Lyell,[1] the circumstance that, as far as was known, no bed or formation of coral of any thickness had been discovered. This objection, which was proposed by Mr. Maclaren in 1842, derives additional force at the present day in the light of my observations in the Solomon Islands.

3. *That these upraised reef-masses in the majority of islands rest on a partially consolidated deposit which possesses the characters of the "volcanic muds" which were found during the "Challenger" Expedition to be at present forming around volcanic islands.*

4. *That this deposit envelops anciently submerged volcanic peaks.*

These two latter conclusions corroborate in a remarkable manner the views, based on the observations of the *Challenger* Expedition, which Mr. Murray has advanced. I will cite the structures of two islands to illustrate these views. In the small island of Santa Catalina I found that the elevated reef was based on volcanic rock with the intervention of a thin brecciated conglomerate. In the island of Treasury I found the volcanic rock covered by a soft, partially consolidated volcanic mud, which attained a thickness of some 300 or 400 feet, and was itself incrusted on the lower slopes of the island by the elevated reef-mass. In the one island, the volcanic peak had been exposed to breaker-action before the reef-corals established themselves. In the other island, the submerged volcanic peak was first brought within the reef-coral zone by the deposition of layers of "volcanic mud" upon it, assisted by the movement of elevation.

With reference to my own bias on this subject, I may here add that during the first eighteen months I passed in the Solomon Islands I was only acquainted with the theory of subsidence, and that after having failed to make my observations harmonise with the theory of Mr. Darwin, I collected my facts with a very confused idea of the direction towards which they were tending. It was therefore a cause of great satisfaction to myself when I first became acquainted with the views held by Mr. Murray.

These calcareous rocks, in the examination of which Mr. Murray used the methods he employed in the case of the deep-sea deposits, may be grouped into two chief classes, according to the proportion of volcanic débris they contain.

The *first class* comprises those rocks which, being largely composed of volcanic débris mixed with the tests of Foraminifera, Pteropods, and other Mollusks, have a composition very similar to that of the volcanic muds at present forming around oceanic volcanic islands in the Pacific. These rocks contain both pelagic and bottom forms of Foraminifera, and four prevailing kinds of them may be distinguished.

1. A friable rock, containing from 5 to 20 per cent. of carbonate of lime, and displaying to the eye only the white specks of minute Foraminiferous tests, with a few of microscopic size, entire Molluscan shells being rarely embedded. The carbonate of lime consists of Coccoliths, Rhabdoliths, Gasteropod, and Lamellibranchiate shells, Echinoderm fragments, calcareous Algæ, and many pelagic and bottom forms of Foraminifera. The residue consists for the most part of the minerals felspar, magnetite, augite, hornblende, fragments of pumice, scoriæ, and other volcanic rocks, with many glassy fragments, and of a fine argillaceous matter which forms about a third of the rock-substance. Rocks of this character form the masses of Treasury and Ugi Islands.

2. A very friable rock, containing from 30 to 35 per cent. of carbonate of lime. These rocks resemble in their general composition the rocks of the previous group, but they differ in the circumstance that they inclose in great numbers the entire shells of Pteropods, Gasteropods, Lamellibranchiates, together with simple corals of deep-sea genera, and the otoliths of fish. There are contained in the residue, in addition to the mineral particles and fine argillaceous material, a great many glauconitic-like casts of Foraminifera. Rocks of this character largely compose Alu, the principal island of the Shortland Islands, and are exposed in the low hills in the rear of Choiseul Bay.

3. A hard, grey fossiliferous limestone, containing usually about 60 per cent. of carbonate of lime and much volcanic débris. Such a rock, which is exposed in the lower courses of the Treasury streams, is chiefly composed of the broken-down fragments of corals and Lamellibranchiate shells, with calcareous Algæ and a few Foraminifera.

4. Coarse-grained rocks composed of the fragments of volcanic and coral rocks in rounded grains. Occasionally larger fragments, together with shells, are imbedded. Such rocks occur on the northern slopes of St. Christoval near the coast.

The *second class* includes those rocks which are largely composed of coral, Molluscan shells, Foraminiferous tests, and calcareous Algæ, with but a small proportion of volcanic débris. The share that each of these four principal constituents takes in the building up of the rock differs widely, and on this basis the following groups have been made. Whether the rock is mainly formed of the massive corals, or whether it is composed of the fragments of such corals broken off by the waves and mixed with shells and other organisms in varying proportions, such a rock as must be forming on the outer slopes of reefs, or whether it is composed of the consolidated calcareous muds and sands which are found at the bottom of lagoons, it has in all cases the same coral origin. The variety in character exhibited in the following groups of coral limestones may be thus in a great measure explained.

1. Coral rocks, properly so-called, which are merely the massive reef-corals in different stages of fossilisation.

2. Coral rocks, which are chiefly made up of calcareous Algæ, fragments of Molluscan shells, corals, and Echinoderms, the interstices being filled up by the tests of Foraminifera and other small calcareous organisms. In the composition of such rocks, which form *the majority of the so-called coral limestones* in the Solomon Islands, coral fragments take only a secondary part. The percentage of carbonate of lime in these rocks varies between 90 and 95, the residue consisting of the common volcanic minerals, siliceous casts of Foraminifera and a fine argillaceous matter.

3. Chalk-like coral limestones, which contain about 95 per cent. of carbonate of lime, and are chiefly composed of the fragments of Molluscan shells, Echinoderms, corals, calcareous Algæ, and Foraminifera. These rocks, therefore, in their general composition resemble the rocks of the second group of coral limestones; but they differ conspicuously in their chalk-like appearance and in being more friable. They occupy the usual surface position of other coral rocks, although not being of common occurrence. I found them overlying the soft Foraminiferous and Pteropod deposit in the Shortland Islands, and they may be sometimes found forming the central elevated portions of existing reefs. One of the specimens of coral this rock contained, according to a determination made

[1] "Principles of Geology," 12th edit. vol. ii. p. 612

by Dr. Leonard Dobbin, a considerable amount of magnesia, and thus approaches a magnesian limestone.

4. Compact fawn-coloured crystalline limestones of a homogeneous texture, in which sometimes reef débris may be observed. These rocks, which are of common occurrence on the lower slopes of the large island of St. Christoval, where they overlie the volcanic rocks of the district, are apparently formed by the consolidation of the ooze found at the bottom of lagoons inside coral reefs.

5. Foraminiferal limestones, which are hard and compact in texture, and are chiefly made up of pelagic and bottom-living Foraminifera, and contain occasionally a few simple corals of deep-sea genera. They contain generally from 75 to 85 per cent. of carbonate of lime, the residue being formed of the common volcanic minerals, siliceous casts of Foraminifera and fine argillaceous matter. These limestones are found at the surface, and in the island of Alu they may be seen to overlie the soft Foraminiferous and Pteropod deposits.

Such are the calcareous formations which are of most frequent occurrence in the Solomon Islands. Three other highly interesting rocks came under my notice, but in each case only in one locality.

(*a*) A Rhynconella limestone. In one of the islets of the Shortland Islands I found a hard grey limestone composed of numbers of Brachiopod, Gasteropod, and Lamellibranchiate shells, with many simple corals of deep-sea genera, embedded in a calcareous matrix largely made up of the tests of Foraminifera (chiefly pelagic forms). The Brachiopod shells belonged to the same species of Rhynconella. Mr. Davidson is inclined to look upon it as the same as *R. Grayii*, a species hitherto represented by a single specimen discovered in the British Museum amongst other natural history objects from the Fiji Islands (?) collected by Mr. J. M'Gillivray more than thirty years since.[1] The simple corals, as Mr. Quelch informs me, belong to the deep-sea genera, Leptocyathus, Stephanophyllia, Odontocyathus, Flabellum, &c. The Gasteropod and Lamellibranchiate shells are, as I learn from Mr. E. Smith, of shallow-water habit. This limestone contained 75 per cent. of carbonate of lime, the residue being made up of the common volcanic minerals, reddish siliceous casts of Foraminifera, and fine washings.

(*b*) A friable earthy rock, which, from the small size of the minerals, the absence of bottom-living Foraminifera, and the scarcity of pelagic forms, resembles a deep-sea clay, and contains a thin coating of manganese between the small layers or folds of the rock. This deposit, which contains about 20 per cent. of carbonate of lime, occurs in the upraised atoll of Santa Anna underneath the elevated reef-mass. On the reef-flat in the vicinity of this deposit there was observed by Lieut. Malan, as already observed, a detached concretionary block of manganese peroxides, one to two cubic feet in size: a typical fragment that I brought home is, according to Mr. Murray, quite similar to smaller masses dredged by the *Challenger* and *Blake*.

(*c*) A hard Foraminiferal limestone, chiefly composed of pelagic Foraminifera. Of this rock, which was found at the surface in Treasury Island, Mr. Murray observes that the organisms, together with the minerals, are similar to those found in deposits of modern seas near volcanic islands at depths of from 500 to 800 fathoms. The Foraminifera are identical with those found in the surface-waters of the tropics at the present day.

With such data as the foregoing at my disposal, it might appear an easy matter to gauge the amount of elevation that has occurred in these regions in recent times. But so great has been the sub-aërial denudation in these islands that although the elevatory movements have brought up to our view a deep-sea clay, with its concretion of manganese, and a Foraminiferal limestone that was probably formed in a depth of from 500 to 800 fathoms, two rocks which occur in islands at opposite extremities of the group, yet, notwithstanding this great upheaval, the calcareous envelopes usually disappear from the slopes of the volcanic islands at heights of 500 or 600 feet above the sea, and never came under my observation in such islands at greater elevations than 900 feet. The rainfall in the elevated interior of the large islands cannot be much under 300 inches in the year, since my own observations place it at about 150 inches at the coast. Of the rapid degradation of the surface which these calcareous districts undergo during a heavy fall of rain, of as much as two to three inches in the same number of hours, I was a frequent witness. In a few minutes the whole hill-slope discharges a continuous sheet of muddy water, the rivulets swell to turbid streams, and the water rushes down the permanent courses with the roar of a mountain torrent. After the rain-storm has passed away, the band of muddy water that fringes the whole length of the coast, to a distance of one-quarter or one-third of a mile from the shore, indicates the loss of material which the land-surface has sustained.

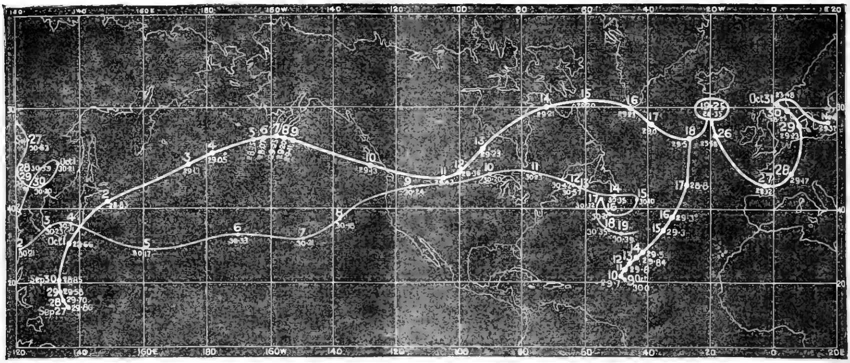
From the general character of these calcareous formations it may be safely inferred that they will be found wherever there has been elevation during the recent period in regions where coral reefs are flourishing. Amongst other localities we may look to the West Indies, the Indian Archipelago, New Guinea (more particularly the south-coast), New Britain, New Ireland, the Santa Cruz Group, the New Hebrides, the Loyalty Islands, New Caledonia, and the Fiji and Tonga Groups, as likely to possess at the sea-border formations of a similar character. In the Solomon Islands, many other islands, such as Ulaua and Ronongo, will be probably found to be counterparts of the islands of Ugi and Treasury.

NOTE.—A reference should be made to the occurrence of worked flints of the palæolithic type in the soil of the cultivated districts of these islands. The natives say they have fallen from the sky, which reminds one of a similar superstition prevalent in the country districts at home as to the source of celts. I was never successful in finding where they came from originally, and would recommend future visitors to this group to pay attention to this point. They are said to occur together with a chalk-like rock on the beaches of Ulaua, an island which I was unable to visit. (For further information on this subject, *vide* some notes of my own read by Prof. Liversidge before the Royal Society of New South Wales, *Journal* for 1883, vol. xvii. p. 328.)

[1] Vide *Annals and Magazine of Natural History*, vol. xvi. p. 444.

TRACING A TYPHOON TO EUROPE

AT the meeting of the Royal Meteorological Society held on November 18, a paper by Mr. Henry Harries, on "The Typhoon Origin of the Weather over the British Isles during the second half of October, 1882," was read. The author had prepared daily charts of the North Pacific Ocean from September 26 to October 10, and by permission of the Meteorological Council the charts of the area between the western coast of America and Eastern Europe were utilised. The earliest evidence of the formation of the typhoon was on September 27, some distance east-south-east of Manilla. At first the movement was towards north-west, 5 miles an hour, but on September 30, when the storm-area extended to 1300 miles north-west of the centre, it curved towards north-east, crossed the south-eastern corner of Japan at 33 miles an hour, and attained a maximum rate of 51 miles per hour on October 2 to 3, after leaving the Japanese coast. In the neighbourhood of the Aleutian Archipelago the progress was very slow until the 9th, when it rapidly increased to 35 miles an hour, and entered Oregon on the 10th. The Rocky Mountains proved to be no obstacle to the progress of the typhoon, which crossed the range at $36\frac{3}{4}$ miles an hour, and, maintaining this rate, passed across the Northern States into Canada. Thence it crossed Hudson's Bay and Labrador, into Davis Strait. Altering its course to south of east it passed the southern point of Greenland on October 16, and two days later, in lat. 55° N., long. 27° W., it was joined by another disturbance, which seems to have formed about October 9 in 20° N., 48° W. The junction of the two storms was followed by a complete cessation of progressive movement for a week (October 19 to 25), and it was during this period was formed as a subsidiary the gale which suddenly arrived over our south-eastern counties upon the morning of October 24, completely upsetting the Meteorological Office forecasts of the previous night The author quoted several records from ships, which went to show that this secondary storm had not formed until nearly midnight; and that reports from outlying coast-stations would not have enabled successful forecasts to be issued before 3 a.m. on the 24th. The 8 a.m. observations for the Daily Weather Report show that with the exception of Hurst Castle the winds on the northern side of the Channel were moderate, but along the French coast heavy gales were blowing. Ships' records indicate that off Start Point a moderate easterly gale began at 6.20 a.m. By 8 a.m. a whole gale from S.E. was blowing



Tracks of the Typhoon and Anticyclone of September and October 1882. The thick line shows the track of the typhoon, the thin line that of the anticyclone. The dates and the lowest and highest ascertained readings of the barometer for the day being given near the positions of the centres at Greenwich noon.

to south-west of Portland, while off the Start at 8.30 a.m. the wind veered to W.N.W. a strong gale. At 9 a.m. the wind off Portland veered to W. and blew with terrific violence. Further east, as far as the Downs, the wind had by noon changed to W. and S.W., and increased to a furious storm, with violent squalls and a terrible sea. As this gale passed away the primary moved into the Bay of Biscay and entered France on the 27th. As in Japan and America, its advance was marked by violent gales and destructive floods over a very extensive area—from Algeria northwards. The damage caused by the floods in England was serious, but trifling compared with the losses in Southern and Central Europe, the destruction being enormous. This typhoon was the principal contributor in making October, 1882, by far the worst within living memory. With this final effort it seemed to have expended its fury, and in crossing France and the Netherlands it gradually filled up. The last trace of the typhoon was in the Baltic on November 1, when it quietly dispersed, after covering over 14,000 nautical miles in thirty-six days, the longest track hitherto followed day by day.

THE NIVAL FLORA OF SWITZERLAND

In the spring of 1883 (the last year of his life), the eminent Swiss naturalist, Prof. Oswald Heer, having finished his "Flora fossilis Arctica," resumed a work with which he had been long occupied before—viz. the preparation of a Nival Flora of Switzerland, in which he proposed to give an account of all the plants found above 8000 feet in that country, and a comparison of these with the Nival flora of other countries. This work, based on very abundant material, was nearly completed before the author's lamented death;—he anticipated being able to finish it in about eight days more had health allowed. The work has now been published in full (as he left it) in the *Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles* (vol. xxix. part 1). The summary of results of this research, which were communicated at a gathering of Swiss naturalists in Zurich, we will here reproduce.

(1) We know at present in Switzerland 337 species of flowering plants which have been observed at from 8000 to 13,000 feet above the sea; 12 of these species have still been found above 12,000 feet.

(2) All these species are found in the lowest division of the Nival region, 8000 to 8500 feet. Above 8500 feet there is no species which is peculiar to this height.

(3) One-tenth of the species of the Nival region consists of species of lowland flora, nine-tenths of mountain plants. Most of the latter belong to the Alpine region, and about a quarter of the species has its greatest distribution over 8000 feet. These are the Nival plants in the narrower sense. While the lowland plants and the plants of the hilly and sub-Alpine region disappear at about 9500 feet, the Nival plants, with a few Alpine species, are the last children of the flora.

(4) The mountain mass of Monte Rosa has the richest Nival flora; which here rises higher than in the Rhætian Alps, and in the latter higher than in the Glärnisch Alps.

(5) The majority of the species are distributed throughout the whole region of the Alps; only a small portion is found exclusively in the east from Orteler to the Gothard, or in the west from the Gothard to Savoy.

(6) About half of the plants of the Nival region come from the Arctic zone, and very probably came over Scandinavia to our region in the Glacial period, since Arctic Europe has the largest number (140) of species

which our Nival flora has in common with the Arctic zone.

(7) This Arctic flora probably arose on the mountains of the Arctic zone, and stood in the same relation, in the Miocene period, to the flora of the Arctic lowland as the present Alpine flora to the flora of the Swiss lowland.

(8) The Miocene Arctic flora advanced to Europe in the Tertiary period, and the European Tertiary flora received from it the types which now characterise the temperate zone, viz. the pine-woods and foliage-trees with deciduous leaves. In course of time these dominated more and more over the tropical and sub-tropical forms, which were the original occupiers of these regions, and became the mother-plants of a portion of the present lowland flora.

(9) In the Glacial period the mountain plants of the Arctic zone descended into the lowland, and spread southwards with the glaciers. As in the Tertiary period the trees and bushes with deciduous foliage wandered southwards, so in the Glacial period did the mountain plants; and that this migration took place radially from the north is proved by the fact that not only in the snow region of our Alps nearly the half of the plant species consists of Arctic species, but also the American mountains, and on the other side the Altai, and even the Himalaya, have quite a number of such Arctic species, and have them in common with the Swiss Alps. We know that already in the Tertiary period, and also in the period of the Upper Cretaceous, a number of plants can be traced from Greenland on to Nebraska, in North America, and on the other hand to Bohemia, Moravia, and on to Southern Europe. Thus in the period of the Cretaceous formation, in the Tertiary, and in the present formation, we find the same phenomenon: that Europe with America has a number of species in common which were formerly indigenous in the Arctic zone, and therefore very probably went out from that as their original home. The same process is thus repeated in different ages; the plant-world of the high north has at all times exercised a great influence on the formation of the plant-covering of Europe.

(10) The endemic flora of the Nival region arose in our Alps. A principal centre of its formation seems to have been the Monte Rosa chain, in which probably, even during the Glacial period, extensive mountain masses of ice and *névé* were liberated.

(11) This flora received at the beginning of the Quaternary period its present character, and spread on the moraines of the glaciers into the lowland and into the mountainous regions of the neighbouring countries.

(12) Its mother flora had probably its abode in the Tertiary mountain country of Switzerland.

NOTES

We understand that the post of Assistant Director of the Royal Gardens, Kew, has been offered to Mr. D. Morris, M.A., F.G.S., the Director of Public Gardens and Plantations, Jamaica. The appointment is in the gift of the First Lord of the Treasury.

So much has been heard during the last few years of the services rendered to the science, industry, and commerce of the West Indies by the public gardens and Government plantations of Jamaica under the superintendence of Mr. Morris, that it is with surprise and regret that we learn that the future efficiency of these institutions is seriously threatened. A Select Committee, it appears, was recently appointed, under a resolution of the Council of Jamaica, "to consider the means of diminishing the expenses of the Government," and, among other suggestions and recommendations, it proposed that the Government cinchona plantations should be sold, and that the public gardens at Kingston should be handed over to the local authorities of that town to be maintained by them, instead of, as heretofore, by the Government, under the Director of Public Gardens. Committees appointed under these circumstances are generally more anxious to justify their existence by making recommendations than careful to inquire where they would be always possible or desirable. The cinchona plantations, thus threatened with extinction, were founded in 1868 by Sir John Peter Grant, and now consist of 150 acres under cinchona, with smaller areas under jalap, tea, and nurseries for timber and shade trees. According to the "Handbook of Jamaica," they distributed in five years to private planters 1200 ounces of cinchona-seed, 1,200,000 cinchona seedlings, 400,000 cinchona plants, besides large quantities of timber and shade trees for re-foresting purposes. The Kingston Gardens, which are to be taken from under Mr. Morris's control, are used as a depot for plants from the other establishments, and also as the centre of distribution of plants and seeds to all parts of Jamaica and of the West Indies; there is no doubt, therefore, that they fulfil important functions.

If there was a single department in the whole Government service on which West Indian economists should have refrained from laying their hands except by way of increasing its scope and efficiency, we should have thought Mr. Morris's department that one. For if the West Indian Islands are ever to emerge from the disastrous economical condition of the past thirty years, and regain their previous flourishing state, it will be by the labours of institutions such as the public gardens, and of men such as Mr. Morris. Their old staples are useless to them, for Europe can buy them cheaper in other markets, and they must find new ones, or plunge deeper into the mire of financial embarrassment and bankruptcy, public and private. This can only be done by experiments and careful observations which no one but a public department and skilled botanists can carry out. Happily the economic value of the gardens in Jamaica have been recognised by the highest authorities. The Royal Commissioners stated that the department was invaluable, and that it was in as good a state as the sums placed at Mr. Morris's disposal would allow. The Governor coincided in this testimony, and added that "Mr. Morris was untiring in his endeavours to induce persons to commence new industries calculated to develop the resources of the island, and to bring about a condition of prosperity which would go far to counterbalance the depression under which the sugar industry of Jamaica now labours." It may be hoped therefore, notwithstanding the report of the Committee on Government Economy, that the department may be permitted to pursue its "invaluable" work on the same lines and with undiminished means.

Mr. Samuel Birch, D.C.L., LL.D., F.S.A., Keeper of the Egyptian and Oriental Antiquities in the British Museum, died, on the 27th inst., in his seventy-second year. Dr. Birch had served in the British Museum for fifty years, during the last part of which he was in charge of the Egyptian and Assyrian antiquities, and it is with this department of Oriental scholarship that his name will ever be associated. His early writings of nearly fifty years ago dealt mainly with Chinese subjects, and one of his first duties at the British Museum was to catalogue the large collection of Chinese coins, and throughout the greater part of his life he manifested his interest in Chinese subjects by various publications. He was twice despatched to Italy on archæological missions on behalf of the Government, and in 1860 founded the Society of Biblical Archæology. His works on all departments of Egyptology fill many volumes, and extend over more than forty years, and at the time of his death he had in the press one work, while another, a new dictionary of hieroglyphics, was nearly completed.

No authentic information is to hand yet to explain the terrible and disastrous colliery explosion at the Mardy mine last week. The atmospheric pressure had been unusually high, and so far as we have been able to gather, coal-dust played an important part in the explosion. No doubt some facts as to the condition of the mine will come out at the inquest on January 12.

THE following are the arrangements for the Friday evening lectures at the Royal Institution before Easter:—January 22: Prof. Tyndall, F.R.S., Thomas Young and the Wave Theory; January 29: Sir William Thomson, F.R.S., Capillary Attraction; February 5: T. Pridgin Teal, F.R.C.S., The Principles of Domestic Fireplace Construction; February 12: Prof. Osborne Reynolds, F.R.S., Experiments showing Dilatancy, a Property of Granular Material, Possibly Connected with Gravitation; February 19: W. K. Parker, F.R.S., Birds, their Structure, Classification, and Origin; February 26: A. A. Common, F.R.S., Photography as an Aid to Astronomy; March 5: Prof. Alexander Macalister, F.R.S., Anatomical and Medical Knowledge of Ancient Egypt; March 12: Reginald Stuart Poole, Corresp. Inst. France, The Discovery of the Biblical Cities of Egypt; March 19: W. H. M. Christie, F.R.S., Astronomer Royal, Universal Time; March 26: Wm. Chandler Roberts-Austen, F.R.S., M.R.I., Chemist of the Mint, on Certain Properties Common to Fluids and Solid Metals; April 2: Howard Grubb, F.R.S., Telescopic Objectives and Mirrors—their Preparation and Testing; April 9: William Anderson, M.Inst.C.E., New Applications of the Mechanical Properties of Cork to the Arts; April 16: Prof. Sir Henry E. Roscoe, M.P., F.R.S.

WE regret to learn that Dr. W. Sklarek, who founded *Naturforscher* eighteen years ago, and has conducted it since, has resigned the editorship of that well-known journal, which will now be published by the Laupp'schen Buchhandlung, Tübingen. Dr. Sklarek, we understand, will edit a new journal of a similar kind to be published in Brunswick.

IT is stated that experiments are being made at Prof. Lieben's chemical laboratory at Vienna, with a new gaslight invented by Dr. Auer. A cotton wick, saturated with an incombustible metal solution, is introduced into the flame of an ordinary Bunsen lamp, the result being a light similar to the incandescent electric light.

MR. LESLIE STEPHEN'S "Life of Henry Fawcett," just published by Messrs. Smith, Elder and Co., contains two very characteristic letters from Darwin, which now see the light for the first time. Mr. Stephen refers to the deep impression made on Fawcett's mind by the "Origin of Species." He became an enthusiastic Darwinian, and in December 1860 published an article in which "he states with his usual firmness the true logical position of Darwin's theory; distinguishing carefully between a fruitful hypothesis and a scientific demonstration; exhibiting the general nature of the argument and the geological difficulty with great clearness, and taking some pains to prove that religion is in no danger from Darwinism." This led to a correspondence with Darwin, and in one of the letters the latter, after referring to his satisfaction at hearing that Mill considered his book a piece of thorough logical argument, adds:—"Until your review appeared I began to think that perhaps I did not understand at all how to argue." In a second letter, dated September 18, 1861, thanking Fawcett for a paper of his read before the British Association, Darwin writes:—"You will have done good service in calling the attention of scientific men to means and laws of philosophising. As far as I could judge by the papers, your opponents were unworthy of you. How miserably A talked of my reputation, as if that had anything to do with it. How profoundly ignorant B [who had said that Darwin should have published facts alone] must be of the very soul of observation! About thirty years ago there was much talk that geologists ought only to observe and not theorise; and I well remember some saying that at this rate a man might as well go into a gravel-pit and count the pebbles and describe the colours. How odd it is that any one should not see that all observation must be for or against some view if it is to be of any service!" Referring to his health Darwin says he is one of those miserable creatures who are never comfortable for twenty-four hours; "and it is clear to me that I ought to be exterminated." Again he says that to him "observing is much better sport than writing." Referring to the timidity with which men of science received his theory, he wrote: "The naturalists seem as timid as young ladies should be, about their scientific reputation." The whole of the correspondence at this time (1860-61) between Darwin and Fawcett, of which Mr. Stephen only gives the two letters here quoted, should be of very great general interest.

THE Vienna Correspondent of the *Times* reports that Dr. Gautsch, the new Minister of Public Instruction in Austria, has prohibited the use of paper ruled in square or diagonal lines within all public schools. The reason of this is that such paper has been found to injure the eyesight of pupils. It has been largely used hitherto in primary schools to facilitate writing and arithmetic lessons; but in future only paper plain or ruled in straight lines is be used.

A STRIKING case of vital resistance in fishes has been lately reported by M. Douaret de Bellesme, Manager of the Aquarium of the Trocadéro in Paris. On November 18 a fishmonger, M. Heydendare, received from Gonda (the centre of fisheries in the region about Rotterdam) a large consignment of fishes packed and preserved in ice. They could not have been caught later than the 16th, and were probably caught on the 15th. On unpacking, a jack was seen to move its gills slightly, and the idea occurred to wash it with fresh water, and immerse it in a vessel. In a few hours the fish was in its normal state, and very lively. M. Heydendare sent it to the Trocadéro Aquarium, where it is to be seen now; it is a fine animal, about 2 feet 4 inches long. Here, then, is a case of a fish out of water more than forty-eight hours (probably three days), packed with little care, along with dead fish and pieces of ice—travelling thus 280 miles, and coming to life again. The lowering of temperature was doubtless very favourable to maintenance of the vital functions.

THREE tall chimneys belonging to Kunheim and Co., of Berlin, were lately destroyed by means of gun-cotton. The largest was about 147 feet high, and 10 feet diameter at the base. In order that it should fall outwards from the city, the charge of gun-cotton (about 57 lbs.) was attached in portions to the side next the city, and to the adjacent sides. All three were exploded simultaneously with a magneto-electric apparatus. The chimney, instead of falling obliquely, collapsed vertically, and on inspection the four walls of the pedestal were found to have been driven outwards. The bricks were all detached from each other, and nearly all entire. The debris was thrown a very little distance. The two other chimneys, treated similarly, fell as was expected, *i.e.* obliquely away from the city. One of them, in falling, broke in two about the middle.

RECENT issues of *Globus* contain two most interesting articles on the investigations into the antiquities of the I land of Bornholm, carried on for a considerable period by its former chief official, Herr Wedel. The Stone Age is extensively represented, although kitchen-middens appear to be wholly absent, by graves, stone coffins, and other objects. The first contain unburnt, as well as the remains of cremated, bodies, but the latter are found under such circumstances as to lead to the conclusion that they belong to a later period. With the exception of stone chisels, all the objects usually found in graves belonging to the Stone Age are found, such as axes, arrow-heads, and the like. Amber ornaments also frequently occur. The stone coffins, which are sometimes very large, are also numerous, and in the mounds with them are frequently found the bones of cremated bodies. On this question, Herr Wedel comes to the conclusion that cremation in Bornholm must have been introduced towards the close of the Stone Age. Most of the objects were apparently made in the island itself; but it is not improbable that the larger flint articles, or possibly the blocks from which they are made, come from places where flint is more plentiful than in Bornholm. Traces of houses belonging to this age have also been found. On the whole, the island during this period does not appear to have been thickly populated; the people moved hither and thither, and appear to have had domestic animals. The remains of the Bronze Age are also very numerous and interesting; of these a full account is given, and it is interesting to notice that, during this period, cremation appears to have been the usual method of disposing of bodies of the dead. Similarly, the finds belonging to the Iron Age are described, and, in conclusion, the writer says that in Bornholm we can trace, without important breaks, human development from the Stone Age down to historic times. Nothing appears, he says, in this long history to show that there was any sudden alteration in the growth of civilisation such as might be caused by the influx of a new tribe. Such an influx, had it taken place, would certainly have left recognisable marks behind it; and, indeed, the thick population of the island in the Bronze and earlier Iron Ages left no opportunity for the settlement of any external people in Bornholm.

The method of placing electric lamps in front of locomotives to illuminate the line, has been tried on many lines, but apparently has not found much favour. Recent experience in Russia appears to show that financial considerations are not alone unfavourable to the system. On the railway between St. Petersburg and Moscow several locomotives were fitted with electric lamps. For a time they gave great satisfaction, lighting the way more than a kilometre in front. But the *employés* began to complain of the contrast between the lighted and the unlighted surfaces painfully affecting the eyes; and doctors ere long reported that there had been several cases of grave injury to the eyes in this way. Hence the lamps were abandoned. The directors have not, however, given up the idea of better illumination of the line, and they now contemplate placing electric lamps so as to illuminate about 1 kilometre on either side of the station.

The best plant at present known for consolidating, by the interlacing of its roots the loose soil of a newly-made embankment is, according to M. Cambier (of the French Railway Service), the double poppy. While the usual grasses and clovers need several months for the development of their comparatively feeble roots, the double poppy germinates in a few days, and in two weeks grows enough to give some protection to the slope, while at the end of three or four months, the roots, which are 10 or 12 inches long, are found to have interlaced so as to retain the earth far more firmly than those of any grass or grain. Though the plant is an annual, it sows itself after the first year, and with a little care the bank is always in good condition.

According to an official statement issued by the Japanese Government, there occurred 553 earthquakes during the nine years and six months preceding December 1884, averaging one earthquake for every six days and six hours. This must, however, refer to the capital and the surrounding district only, and earthquakes of great violence can alone be counted, for Prof. Milne was able to trace an average of an earthquake per day in Nagasaki, in the extreme south of the Japanese archipelago. The official statistics, on the other hand, may possibly be compiled from the returns of local officials all over the country, in which case only those shocks which caused loss of life or damage to property would be included. If this hypothesis is correct, we should have an average of more than an earthquake per week which was so violent that it caused injuries to life or property sufficiently serious to attract the attention of the local authorities, and, in their judgment, to require a report to the central Government.

M. Herzen contributes to a recent number of the *Revue Scientifique* an account of certain experiments which he made recently on the thermic sense in animals. His observations on man had already led him to the conclusion that impressions of heat are conveyed to the brain by the gray substance of the spinal marrow. Animals, he found, on the other hand, do not react under the impressions of moderate heat, and when the latter is excessive the reaction is one of pain, not of the specific sensation of heat. On the contrary, however, cold operates on them actively, and M. Herzen succeeded in demonstrating by his experiments that impressions of cold in animals are really conveyed by the medullary rays which transmit the impressions of touch. The various experiments which are briefly described in the article satisfied him that the cortical lesions which destroy sensibility to touch also destroy that of cold, and, when the first is preserved, the latter likewise remains; and that, in brief, impressions of contact and of cold are transmitted in the same way to the same regions of the cortical layer of the hemispheres.

In a recent article on the work of the Asiatic Society of Bengal, originally founded by Sir William Jones, during the first century of its existence, we referred to the division of its publications into literary and scientific, the numbers of the *Journal* of the Society in each case being quite distinct. We have now before us the scientific numbers of the *Journal* for the past year, and they show remarkable activity. It should be remembered that there are independent societies in Madras and Bombay, so that the Bengal Society's publications represent the work of one Presidency only. Amongst the scientific papers published during the year are the following:—The theory of the winter rains in Northern India, by Mr. Blanford, the President of the Society, and the Meteorological Reporter to the Government of India; descriptions of some new Asiatic diurnal *Lepidoptera*, chiefly from specimens contained in the Indian Museum in Calcutta, by Mr. Frederic Moore; a new species of *Simulium* from Assam, by Dr. Becher, of Vienna; variations of rainfall in Northern India during the sun-spot period, by Mr. Pearson, the Meteorological Reporter for Western India; a description of a new Lepidopterous insect belonging to the Heterocerous genus *Trabala*, by Mr. Moore; *Phyllothelys*, a remarkable genus of *Mantodea*, from the Oriental region, by Prof. Wood-Mason; notes on the Indian *Rhynchota*, by Mr. Atkinson; a list of Lepidopterous insects collected in Cachar, by Mr. Moore (the first part, dealing with *Heterocera*, has alone been published so far); revised synopsis of the species of *Chæradodis*, a remarkable genus of *Mantodea*, common to India and tropical America, by Prof. Wood-Mason; and finally, an account of the two remarkable south-west monsoon storms in the Bay of Bengal in 1883, by Mr. Eliot, the Meteorologist to the Bengal Government. It should be added that these papers are, where necessary or desirable, copiously illustrated.

It is interesting to note that the various species of Salmonidæ at the Aquarium, South Kensington, have been recently spawned by artificial means, the sea trout being crossed with the Gilleroo and Levenensis trout. A very large yield of ova was obtained, all of which presented signs of healthiness and complete impregnation. Although the fish spawned have been in captivity for four years, they shed their eggs with the same ease as those subjected to natural conditions.

A LARGE number of Salmonidæ eggs are being incubated at the Buckland Museum. It will be remembered that fish-hatching operations were carried out extensively here by the late Frank Buckland, but after his death they subsided, and until this year the apparatus used by him were not called into use. The re-introduction of this feature will afford much gratification to visitors, and especially to those having the interest of the great naturalist's collection at heart. Besides, the authorities have, by this act, shown their sympathy with fish-culture, and have also set an example which might be emulated by the public elsewhere. It may not be generally known, but the Museum does not contain nearly all the exhibits comprised in the Buckland Collection, which cannot be adequately shown to the public in the limited space allotted to the exhibits.

THE Dutch Government has instituted Christmas telegraphic messages at a reduced rate, containing merely the name and address of senders and receivers.

THE numbers of that valuable periodical, the *Indian Antiquary* for 1885, though of course mainly occupied with papers on the special field of Indian scholarship, contain also many of general scientific interest. Thus a considerable space is devoted to folk-lore: there are four papers on the folk-lore of Southern India; one on that of Western India; a paper on the omens from the falling of house-lizards, which is curious from the minuteness with which every part of the body, even the smallest, on which a lizard could fall is provided with its appropriate omen, that for men and women being different. The modes by which evil omens may be averted are added. There is also a selection of Kanarese popular ballads. There are also two learned articles by Prof. V. Ball, in which he seeks to identify the animals and plants of India which were known to early Greek authors. One result of his interesting investigations (as indeed of all similar investigations into the works of early writers, Marco Polo, for example), is to show that most of the statements of these writers, usually ridiculed as extravagant or fictitious, rest on substantial bases of fact.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. A. Murray; an American Robin (*Turdus migratorius*) from North America, presented by Mr. A. Saunders; two Hybrid Ruddy Sheldrakes (between *Tadorna rutila* and *Chenalopex ægyptiaca*), bred in France, deposited; a Sing-Sing Antelope (*Cobus sing-sing* ♂) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

EFFECT UPON THE EARTH'S MOTION PRODUCED BY SMALL BODIES PASSING NEAR IT.—Prof. H. A. Newton has published a paper on this subject in the *American Journal of Science* for December, 1885. He points out that the space through which the earth travels is traversed also by small bodies or meteoroids. The impact of these bodies upon the earth and the consequent increase of the earth's mass have their effect upon the earth's motions both of rotation and revolution. The moon's orbit and the length of the month likewise suffer change. Prof. Oppolzer (*Astron. Nachrichten*, No. 2573) has considered the amount of these actions, and has computed the density which the meteoroid matter must have in the space which the earth is traversing in order to account for the observed and unexplained acceleration of the moon's mean motion. But a body that passes near the earth has also an action of like character by reason of the attraction of gravitation alone, and the conclusion at which Prof. Newton arrives is that these latter bodies do not have an effect at all comparable with that produced by those which actually come into the earth's atmosphere. In fact his investigation shows that the effect upon the earth's motion of the meteors that come into its atmosphere exceeds at least one-hundredfold that of the meteors that pass by without impact.

THE TEMPERATURE OF THE SURFACE OF THE MOON.—Two important memoirs on this subject have recently been published in a separate form. Of these the first is one by the Earl of Rosse and Dr. Otto Boeddicker on "The Changes of the Radiation of Heat from the Moon during the Total Eclipse of October 4, 1884," communicated to the Dublin Royal Society. It will be remembered that Dr. Boeddicker gave a summary of his observations in a communication to NATURE, vol. xxx. p. 589, and stated that the minimum of heat was observed later than the minimum of light. As, however, the diminution of heat was very rapid, and amounted to $\frac{89}{90}$ of the entire amount received from the unobscured full moon, the conclusion from these observations would appear to be that the amount of heat radiated to us from the moon itself as distinguished from that merely reflected or diffused by it, is almost insensible.

The second memoir is by Prof. Langley (the conclusions of which will be found on p. 211), and was communicated to the American National Academy of Sciences, October 17, 1884. It commences with a review of previous researches, Lord Rosse's papers being carefully summarised. The diathermancy of glass for solar and lunar rays respectively, is next investigated, and it was found, as Lord Rosse had previously done, that a much larger percentage of the solar than of the lunar rays was transmitted through glass. Prof. Langley next endeavoured to ascertain whether this effect was due to a general absorption resulting in a heating of the moon's soil with a consequent radiation of heat of a much lower refrangibility than that received, or to a *selective* absorption by the moon of the more refrangible rays. His observations convinced him that the latter condition prevails to a remarkable extent, so that there is "a preponderance in the lunar spectrum of the rays of long wave-length, and hence a tendency to cause a smaller percentage of lunar rays to be transmitted by glass than of solar, and this independently of any effect from heat re-radiated by the lunar soil."

It had been generally assumed, prior to Prof. Langley's bolometer researches, that our atmosphere was most transparent to the visible portion of the spectrum. Prof. Langley has shown, on the contrary, that the coefficient of transmission steadily increases towards the extreme infra-red, up to the point $\lambda = 3\mu$, where the solar spectrum ceases to give any further evidence of its existence. The present research seems to show that this sudden termination of the spectrum is not due to our atmosphere, for Prof. Langley has been able to form a heat-spectrum from the lunar rays, which he is able to trace considerably further in the longer wave-lengths than that of the sun. This lunar spectrum shows two maxima, one fairly corresponding with "the solar curve maximum, the second indefinitely lower down in the spectrum, corresponding to a greater amount of heat at a lower temperature." This latter portion of the spectrum Prof. Langley considers as being clearly due to the moon itself, and as revealing its real temperature. This temperature, he concludes from his study of the spectra of cold bodies, is lower than that of melting ice. In a further paper read before the National Academy in November last, Prof. Langley states that a comparison of the spectra obtained from the moon in summer with those obtained in winter, shows that a much greater amount of heat is received in the latter season than the former, a difference probably due to the greater amount of aqueous vapour in our atmosphere during summer. He also mentions that he has made the first attempt to determine the temperature of space by direct experiment.

NEW COMET.—A telegram from Prof. Krueger, Kiel, announces the discovery of a new comet by Mr. W. R. Brooks, Red House Observatory, Phelps, New York. The following places have been obtained at the Harvard College Observatory:—

Cambridge M.T.		R.A.		Decl.
h. m.		h. m. s.		° ′
1885 Dec. 27, 8 11·6	...	19 55 40	...	4 8·0 N.
28, 6 30·0	...	19 59 3	...	4 31·6 N.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *JANUARY* 3-9

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 3

Sun rises, 8h. 8m.; souths, 12h. 4m. 48·8s.; sets, 16h. 2m.; decl. on meridian, 22° 48′ S.: Sidereal Time at Sunset, 22h. 55m.

Moon (New on January 5) rises, 6h. 7m.; souths, 10h. 36m.; sets, 15h. 3m.; decl. on meridian, 18° 12′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 17 ...	10 28 ...	14 39 ...	20 41 S.
Venus ...	10 6 ...	15 6 ...	20 6 ...	12 23 S.
Mars ...	22 13* ...	4 46 ...	11 19 ...	5 45 N.
Jupiter ...	23 32* ...	5 31 ...	11 30 ...	0 59 S.
Saturn ...	15 14 ...	23 24 ...	7 34* ...	22 33 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Phenomena of Jupiter's Satellites

Jan.	h. m.		Jan.	h. m.	
4 ...	1 13	IV. ecl. reap.	6 ...	6 58	I. occ. reap.
4 ...	1 29	II. ecl. disap.	7 ...	1 51	I. tr. ing.
4 ...	6 44	II. occ. reap.	7 ...	4 6	I. tr. egr.
5 ...	6 29	III. ecl. disap.	8 ...	1 26	I. occ. reap.
5 ...	7 23	I. tr. ing.	9 ...	1 11	III. tr. ing.
6 ...	1 46	II. tr. egr.	9 ...	4 0	III. tr. egr.
6 ...	3 31	I. ecl. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, January 3.—Outer major axis of outer ring 46″·6; outer minor axis of outer ring 20″·5; southern surface visible.

Jan.	h.	
9 ...	2 ...	Mercury at greatest elongation from the Sun, 23° west.

Variable Stars

Star	R.A.	Decl.			
	h. m.	° ′			h. m.
U Cephei ...	... 0 52·2 ...	81 16 N. ...	Jan.	3,	1 5 *m*
W Virginis ...	... 13 20·2 ...	2 47 S. ...	,,	4,	9 30 *M*
δ Libræ ...	... 14 54·9 ...	8 4 S. ...	,,	5,	18 13 *m*
U Coronæ ...	... 15 13·6 ...	32 4 N. ...	,,	6,	3 41 *m*
R Serpentis	... 15 45·4 ...	15 29 N. ...	,,	5,	*M*
U Ophiuchi	... 17 10·8 ...	1 20 N. ...	,,	5,	4 45 *m*
			,,	6,	0 53 *m*
			,,	6,	21 1 *m*
δ Cephei ...	... 22 24·9 ...	57 50 N. ...	,,	6,	17 0 *m*
S Aquarii ...	... 22 51·0 ...	20 57 S. ...	,,	6,	*M*

M signifies maximum; *m* minimum.

Meteor Showers

Meteors have been observed during this week in former years from the following radiants:—Near β Aurigæ, R.A. 93°, Decl. 43° N.; R.A. 145°, Decl. 5° N.; R.A. 150°, Decl. 67° N.; and R.A. 181°, Decl. 35° N.

GEOGRAPHICAL NOTES

THE current number of *Petermann's Mittheilungen* contains an account of Herr Menge's second journey in the Somali Peninsula, accompanied by an excellent map showing the courses of both journeys. The traveller's meteorological observations and measurements, worked out by Dr. Schmidt of Gotha, are appended to the paper. Dr. Paulitschke's account of his journeys to Harar and amongst the Northern Gallas is concluded in this number. It contains a mass of interesting information of all descriptions with regard to this region. In an appendix a sketch is given of the scientific results of the journey, arranged under the heads—astronomical and magnetic observations, topography, anthropology and ethnography, and natural history.

THE *Bulletin* of the Paris Society of Geography just published (3e trimestre, 1885) contains the full text, with maps, of Dr. Heis's journeys amongst the Laos. M. Errington de la Croix, under the title of "Seven Months in the Tin Country," describes the method of working the tin-mines of Perak, in the Malay Peninsula. The only other paper in the number is one of great interest by M. Pinast on certain explorations of his in the State of Panama, especially in the regions around the Chiriqui lagoon, and the districts inhabited by the Guaymi Indians.

THE last Ergänzungsheft, or supplementary number of *Petermann's Mittheilungen*, is a lengthy account by Dr. Boas of his journeys during 1883 and 1884 in Baffin Land. It is divided into four main parts: an account of the journey from day to day, worked into a narrative; the history of past discoveries in the same region; geography; and, lastly, anthropo-geography. One appendix contains a long list of Eskimo place-names in Baffin Land, with their meanings; another gives a number of astronomical observations at various stations. The work is accompanied by two maps, one of Cumberland Sound and Cumberland Peninsula; the other represents the distribution of Eskimo tribes in Baffin Land.

THE current number of the *Proceedings* of the Vienna Geographical Society (Bd. xxviii. No. 11) contains a paper entitled "Shamanism in Upper Austria," by Dr. Zehden. The district specially referred to is the wide granite plateau which forms the watershed between Bohemia and Upper Austria, and the paper describes the old superstitions and practices still surviving amongst the comparatively primitive people who inhabit the district. The application of the term "Shamanism" to these in the bulk is curious, and somewhat questionable. Shamanism is the form of Buddhism ("Northern Buddhism") prevailing amongst the Mongols and Thibetans, the *Shaman*, or priest, being one who has overcome all his passions. It is said to be a word of Hindu origin. The Pope of this sect, which differs from the Buddhism of India and Ceylon more in state and power than in doctrine, is the Dalai Lama at Lhassa. It has an enormous literature, which is described as the dreariest in existence. Like every other form of religion, and perhaps more than most religions of civilised peoples, it has its superstitious practices and beliefs; but there appears no more excuse for transferring this name from Thibet and Mongolia to Austria, and applying it to superstitions there, than for calling the latter Babylonian, Chaldean, or something else that has no connection whatever with them. The number also contains further letters from Dr. Lenz, in charge of the Austrian expedition to the Congo.

A TELEGRAM was received in Berlin on the 27th inst., announcing the death of Dr. Büttner, a German explorer travelling in Bonnyland, in Africa. The deceased, like Livingstone, was formerly engaged in missionary work in South Africa.

TEMPERATURE OF THE SURFACE OF THE MOON

IN a memoir on this subject presented to the U.S. National Academy of Sciences by Prof. S. P. Langley, the author concludes by reviewing as follows our sources of information, and weighing the imperfect and contradictory results each has brought us:—

(1) *Direct Measurement of Lunar Heat as compared with Solar.*—Our direct comparison indicates that we receive nearly the whole proportion of solar energy from the full moon that we should expect to get from a diffusive disk of the same angular aperture. This heat must in reality be partly diffused and partly radiated, and we do not know (from the present observations) in what proportions these two kinds enter. So far as the observation itself is reliable, we may, however, infer that our atmosphere is permeable to most of the lunar heat of either kind, but the method is unfortunately subject to such large sources of constant error, that we cannot derive great confidence from the apparent agreement of different observations or even of different observers. It may be said, however, to create a certain presumption that the earth's atmosphere is diathermanous to heat of lower wave-length than has been heretofore supposed, *and of lower wave-length than appears to reach us from the sun.*

(2) *Comparison of Moon's Heat with that of Leslie Cube.*—If we may draw any inference from this class of observations it is that the sunlit surface of the moon is not far from the freezing temperature, but not so far below as we might expect to find that of an absolutely airless planet.

(3) *Transmission of Lunar Heat by the Earth's Atmosphere.*—Our observations indicate a not materially greater co-efficient of transmission for lunar heat than for solar; and though their

limited number and the uncertainty of the correction for change of heat with phase render more certainty as to the fact desirable, we may (accepting them as probable) reason thus.

Previous observations both at Allegheny and Mount Whitney have shown that the solar rays are transmitted with greater and greater facility (except for cold bands) as the wave-length increases up to the point (near $\lambda = 3^{\mu}$) where they suddenly disappear altogether. This shows either that (1) the solar heat, which, according to the customary assumption, exists to an unlimited wave-length before absorption, has here been cut off by a suddenly absorbent action, like that of a cold band extending indefinitely below 3^{μ}, or (2) that, either through a precedent absorption of such rays in the sun's own atmosphere or their non-existence, no solar rays below 3^{μ} present themselves to our atmosphere for admission.

The first view is that which I have treated as most in accordance with received opinion. It is not, however, the only one, since the second is not to be absolutely rejected, considering our experimental ignorance of the laws of radiation from gaseous bodies for great wave-lengths. Of these two hypotheses we see that, according to the first, our atmosphere is quite opaque to all heat below 3^{μ}, and the writer's (unpublished) experiments show that heat above this point must come almost wholly from a source much above 100° C. In this view, then (unless we agree that the radiations from the lunar soil correspond to a source much above 100° C.), we conclude that sensibly none of them pass our atmosphere, but that what we receive is diffused and reflected heat coming within the range of the known solar energy spectrum, and transmitted with nearly the same facility as solar heat, or if with a little greater, because lowered in wave-length by selective reflection at the lunar surface, not by absorption and re-radiation from the lunar soil.

In the second view, for anything we have absolutely known to the contrary, our atmosphere may be permeable to radiations of any wave-length below 3^{μ}, and we could draw no certain inference, even if the lunar radiation were more distinctly different in transmissibility than it is.

As a matter of fact, with the actually limited difference in the character of its transmissibility, a difference which, as so far determined, is of the same order as that of the error of observation, we have no ground then from this present class of observation (*i.e.* Class 3) for any absolute conclusion one way or the other. But, we repeat, it seems to be a probable inference from our whole work that the earth's atmosphere is more diathermanous to heat of extremely low refrangibility than has heretofore been supposed.

(4) *Comparative Transmission of Glass for Lunar and Solar Heat.*—The evidence here, which at first seems to so directly support the view of a sensible radiation from the surface of the moon, proves, on examination, to be subject to other interpretation, for the observed effect is almost certainly due in part to a degradation of wave-length by selective reflection from the lunar soil.

We can draw no absolute conclusion, then, from this evidence, at first in appearance so promising, though we may say that it certainly indicates an increased probability for the view that radiations from the lunar soil may be transmissible by our atmosphere.

(5) *Observations during a Lunar Eclipse.*—If our own observations in this respect are imperfect, those of Lord Rosse, before cited, are, on the other hand, clear. They appear to bear but one interpretation—that all heat from the moon disappears immediately that it passes into the earth's shadow, and there is no evidence of any being retained, for any sensible time, more than if it were reflected.

It is so difficult to conceive that while the moon has been storing heat during many days of sunshine, it can part with it instantly, so that the temperature of the whole earthward surface of the planet disappears in an inappreciable interval, that most will see in this observation an argument against the existence of any such heat sensible to us at any time whatever.

(6) *Formation of a Lunar Heat Spectrum.*—The observations made here with the lunar heat spectrum are as yet incomplete. With improving experience and apparatus, we hope to make others which shall give information of a character no other means can furnish (see note, *infra*).

Conclusion.—While we have found abundant evidence of heat from the moon, every method we have tried, or that has been tried by others, for determining the character of this heat appears to us inconclusive; and, without questioning that the moon radiates heat earthward from its soil, we have not yet found any experimental means of discriminating with such certainty between this and reflected heat that it is not open to misinterpretation. Whether we do so or not in the future will probably depend on our ability to measure by some process which will inform us directly of the wave-lengths of the heat observed.

Note added February, 1885.—Since the above paragraph was written, we have succeeded in obtaining measures with rock-salt prisms and lenses in a lunar *heat spectrum*. These difficult measures must be repeated at many lunations before complete results can be obtained; but, considering their importance to the present subject, we think it best to state now in general terms, and with the reserve due to the necessity of future experiment, that they indicate two maxima in the heat curve—one corresponding within the limits of errors of observation to the solar curve maximum, the second indefinitely lower down in the spectrum, corresponding to a greater amount of heat at a lower temperature. Exactly what temperature this latter corresponds to we have no present means of knowing. We have succeeded, however, in forming a measurable heat-spectrum from the surface of a Leslie cube containing boiling water, and the maximum ordinate in the lunar heat curve appears to be below the maximum ordinate in the hot water curve. The inference from this is, of course, that the temperature of the lunar soil is, at any rate, below that of boiling water, and in an indefinite degree.

We cannot close this note without calling attention to the remarkable fact that we here seem to have radiations from the moon of lower wave-length than from the sun, which implies an apparent contradiction to the almost universally accepted belief that the sun's emanations, like those from any heated solid body, include all low wave-lengths representing temperatures inferior to those certainly emitted.

SYMBIOSIS BETWEEN FUNGI AND THE ROOTS OF FLOWERING PLANTS

A VERY remarkable phenomenon has for some time past attracted the attention of a few physiological botanists in France and Germany, and was the subject of an interesting discussion at the annual meeting of the Association of German Naturalists and Physicians at Strassburg in September last. This is no less than the discovery of the fact, which may now be considered fairly established, that a considerable number of phanerogams, especially forest trees, do not draw their nourishment directly from the soil, but through the medium of an investing layer of fungus-mycelium, to which B. Frank gives the name of Mycorhiza.

The observations which first called the attention of botanists to this interesting subject were those of F. Kamienski, on *Monotropa hypopitys*, published in the *Mém. de la Soc. Nationale des Sci. Nat. de Cherbourg*. He came to the conclusion that this plant is not, as is usually believed, a parasite, the most careful observation failing to detect any haustoria or other parasitic union with the root of any host. On the other hand, he found the root of the *Monotropa* to be completely covered by the mycelium of a fungus, which branches abundantly, and forms a pseudo-parenchymatous envelope, often two or three times the thickness of the epidermis, and especially well developed at the apex of the root. This fungus, the species of which M. Kamienski is unable to determine, is entirely superficial, not penetrating into the living cells, though occasionally forcing its way between those of the epidermis. He contends that the *Monotropa* derives its nourishment from the soil entirely through the medium of this fungus-mycelium; the only parts of the root which are in actual contact with the soil are composed of lifeless cells with no power of deriving nutriment from them. The connection of the fungus with the roots of the *Monotropa* is not one of parasitism, but of true symbiosis, each of the two organisms deriving support and nutriment from the other.

More recently similar observations on the mode of nutrition of trees belonging to the natural order Cupuliferæ have been made by Dr. B. Frank and confirmed by M. Woronin (both recorded in the *Berichte der Deutsch. Bot. Gesellschaft*). Dr. Frank finds the roots of our native oaks, beeches, hornbeams, chestnuts, and hazels, to be covered by a dense cortex of Mycorhiza, organically associated in growth with the root, and composed entirely of fungus-hyphæ, completely enveloping the whole of the root, even the growing point. The structure of this cortex is that of a sclerotium; it is composed of a dense mass of hyphæ, varying in diameter from 2 to 10 micro-millimetres, usually in several layers, other endophyllic hyphæ penetrating from them into the root between the epidermal cells, these being still slenderer than those of the envelope. By this structure, the formation by the tree of root-hairs is entirely prevented, and it is through it alone that nutriment is absorbed out of the soil. It makes its appearance first on lateral roots of the young seedling, and is constantly being replaced by fresh formations on older roots. Dr. Frank found this Mycorhiza invariably present on every root examined of trees belonging to the Cupuliferæ, also occasionally on Salicaceæ and Coniferæ, but not on woody plants belonging to other natural orders, nor on any herbaceous plant. He also regards the phenomenon as an example of symbiosis, comparable in all essential points to that of lichens, the Mycorhiza corresponding to the fungal element, the tree itself to the algal gonidia. Dr. Woronin confirms these statements in relation to Coniferæ, Salicaceæ, and some other trees, and thinks it probable that the fungus is the mycelium of a *Boletus*. He regards it, however, as truly parasitic.

In the discussion which took place at Strassburg, Dr. Frank stated that the fact of this phenomenon having been observed especially in the Cupuliferæ, was probably due to the partiality of these trees for soil rich in humus. He had observed it also in the Abietineæ among Coniferæ, the Salicaceæ, the alder and birch among Betulaceæ, and in one instance each in the lime and blackthorn. He regards it as probably much more widely diffused than previous observations had suggested. Prof. de Bary, who accepts the explanation of the phenomenon as an example of symbiosis, pointed out that a similar relationship has long been known between Orchideæ and fungus hyphæ. Observations in the same direction have also been made by Riess and Janczewski. ALFRED W. BENNETT

NORWEGIAN TOADSTOOLS

AMONG the various interesting facts regarding the history of cryptogamic plants given in the new edition of Prof. Schübeler's great work on the flora of Norway, special interest attaches to the results of his experiments on *Amanita muscaria*, one of the commonest of the Norwegian toadstools. According to Dr. Schübeler, we have in this mushroom the source whence the ancient Scandinavians derived a preparation whose intoxicating and half poisonous properties induced symptoms of frenzied excitement, similar in all respects to those exhibited by the old northern warriors when taking part in a "Berserksgang," which appears to have been very similar to the so-called "running amok." Prof. Schübeler founds his opinion on the evidence given by the Russian writers, Krascheninnikow, Erman, and others, as to the effects produced on the Kamchatkans by a decoction of the Amanita, which they used as an intoxicating drink until they were brought into closer contact with the Russians, from whom they have acquired the practice of drinking spirits. In the present day this use of the Amanita seems to be limited to the nomadic Korjakes, with whom the neighbouring Kamchatkan tribes carry on a profitable trade, giving only one or two of these mushrooms in exchange for a reindeer. According to the testimony of the Kamchatkans, the first symptom noticed after drinking this so-called "Muchamór liqueur," one of whose ingredients is said to be the juice of *Epilobium angustifolium*, is a trembling in the limbs, followed after a time by great flushing of the face and general excitement and irritability, which in the case of many is accompanied with an abnormal increase of muscular force. Thus an instance is recorded in which a man while under the influence of this stimulant ran 15 versts carrying a sack of flour on his back weighing 120 lbs., which in his ordinary condition he could barely lift. On comparing the symptoms of intoxication by muchamór recorded among the nomads of North-Eastern Asia with the accounts given by Icelandic and other northern authorities of the condition of the Berserkers in their frenzy, Dr. Schübeler finds such complete harmony that there can be no doubt of the identity of the causes to which both may be referred. We know, moreover, that while the descriptions of the Berserkergang forcibly recall the frenzy induced by the use of hachish, or opium, neither of these stimulants could have been attainable in Iceland in ancient times, nor could brandy have been used by the northmen, since it was not introduced into Norway before 1531. The employment of mead or ale by the Bersekers is equally negatived by the symptoms recorded, which the writer seems to have traced beyond a doubt to their true source. It is worthy of notice that as early as the beginning of the eleventh century the law-givers of Iceland recognised the Berserkergang as a manifestation of frenzy, for which the actors were to be held accountable, while a law was introduced in 1123 which ordained that every man who took part in these outbreaks should be banished from the island for three years, and that a similar punishment should be awarded to all who were present and who did not help to bind the Berserkers and watch over them till their excitement had passed away.

SCIENTIFIC SERIALS

Bulletin de l'Académie royale de Belgique, October 10.—Note on the crepuscular lights observed towards the end of the year 1883, by M. Hirn. A new explanation is here suggested of this phenomenon, which is attributed to a highly electric condition of the upper atmospheric layers in combination with particles of matter floating round the globe, and possibly due to the Krakatoa eruption.—On the notion of force in modern science, by M. Hirn. In this essay force is removed from the almost mystic domain it has hitherto occupied, and brought within the sphere of actual experience. The question to be determined by science is, whether gravitation, electricity, heat, &c., are to be regarded as distinct entities, or different forms of the same element absolutely distinct from what we call ponderable matter. But owing to the prevailing confusion regarding the nature of force, it is better for the present to study its various dynamic manifestations, than to attempt to reduce them to one element.—Analysis of some rocks from the "rivers of stone" in the Falkland Islands, by A. Renard. Amongst these specimens is a square prism with regular polyhedric breakage showing a granitoid texture, and altogether typical of the eruptive masses frequently interspersed amongst Palæozoic formations like those of the Falkland Islands. This fragment must be classed in the group of diabase rocks, and may serve to throw some light on the origin of the remarkable "rivers of stone" described by Darwin and Wyville Thomson.—Note on the gemmation of the channels in the planet Mars, by F. Terby. It is suggested that this curious phenomenon may be the beginning of a periodical enlargement of the channels due to causes for which no analogy can be found on the terrestrial globe.—The ancient geography of Western Asia elucidated by means of the cuneiform inscriptions, by M. Delattre. By a careful study of the itineraries and warlike expeditions described in the Assyrian and Babylonian records the author endeavours to determine the position of numerous localities unknown to the Greek and Latin writers.—The origin of the Flemish people, by L. Vanderkinden. In reply to M. Wauters' recent memoir, the author shows conclusively that the Saxon and Frisian elements are largely represented in the present populations especially of Western Flanders.

Rivista Scientifico-Industriale, October 31.—Paramagnetism and diamagnetism, by Prof. Carlo Marangoni.—On the velocity of the rays polarised round the interior of a body endowed with rotatory power, by Prof. Augusto Righi.—Experiments on the heating of boilers with petroleum, by the editor.—On the native arsenic of the Valtellona district, by D. Bizzari and G. Campani.

Rendiconti del Reale Istituto Lombardo, November 12.—Critical and exegetic essays on the sources of Roman jurisprudence, by Prof. C. Ferrini.—Theoretical treatment of the question of the ventilation of rooms, showing that in all cases the ventilating apparatus should be placed above, by Prof. R. Ferrini.—On a question of priority of discovery in bacterio-therapeutics, by E. L. Maggi.—Analytical functions of a single variant with any number of periods, by E. F. Casorati.—Meteorological observations made at the Brera Observatory, Milan, during the months of August and September.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 17.—"An Experimental Investigation into the Form of the Wave-Surface of Quartz," by James C. McConnel, B.A. Communicated by R. T. Glazebrook, M.A., F.R.S.

The paper contains an account of a number of measurements of the well-known "dark rings" of quartz. Each ring is due to one wave being retarded in the quartz behind the other by an integral number of wave-lengths, so the measurements give the directions through the plate of quartz corresponding to a series of known retardations. The relative retardation is, especially in a crystal of weak double-refracting power like quartz, mainly dependent on the distance between the two sheets of the wave-surface. Thus my observations really give the separation between the two sheets at various points, and it is in this separation that the peculiarities of quartz are most strongly marked, and the various expressions put forward by theory most widely divergent.

I found it convenient to treat separately the region near the axis, where the abnormal form of the wave-surface of quartz is most obvious. I have compared my results with nine different theories, each of which gives an expression of one of the two following forms:—

$$D^2 = P_1^2 \sin^4 \phi + D_0^2.$$
$$D^2 = P_2^2 \sin^4 \phi + D_0^2 \cos^4 \phi$$

Here D is "the number of wave-lengths by which one wave lags behind the other in air, after the light has traversed normally a plate of quartz 1 millimetre thick, the normal to whose faces makes an angle ϕ with the optic axis." D_0 is the value of D when $\phi = 0$, and is known from the rotatory power, and P_1 and P_2 are constants to which the theories assign different values. By inserting the observed values of D and ϕ, I obtained a value of P_1 and P_2 from each ring. The results from one plate about 20 millimetres thick were as follows:—

ϕ ...	4° 24′	5° 51½′	6° 51½′	7° 40½′	8° 23½′	9° 38′	11° 41′
P_1 ...	15·054	15·207	15·220	15·260	15·249	15·258	15·269
P_2 ...	15·220	15·293	15·290	15·311	15·295	15·292	15·292

Similar results were obtained from a second plate about 27 millimetres thick.

From these figures I concluded that the second expression was the correct one, and that $P_2 = 15 \cdot 30 \pm \cdot 01$. There is a considerable discrepancy in the case of the first ring, of which two possible explanations are given in the paper.

Cauchy gives $P_2 = \frac{a - b}{a^2 \lambda} = 15 \cdot 351$, where a and b are the wave-velocities perpendicular to the optic axis.

$$\text{Lommel gives } P_2 = \frac{1 - a^2}{1 - b^2} \cdot \frac{a + b}{2a} \frac{a - b}{a^2 \lambda} = 15 \cdot 178.$$

$$\text{Kettler} \quad ,, \quad P_2 = \frac{a + b}{2b} \frac{a - b}{a^2 \lambda} = 15 \cdot 486.$$

$$\text{Sarrau} \quad ,, \quad P_2 = \frac{a + b}{2a} \frac{a - b}{a^2 \lambda} = 15 \cdot 306.$$

The other five, MacCullagh, Clebsch, Lang, Boussinesq, and Voigt, have the first form of expression giving

$$P_1 = \frac{a + b}{2a} \frac{a - b}{a^2 \lambda} = 15 \cdot 306.$$

Thus Sarrau alone succeeds in explaining the observations satisfactorily.

For the larger values of ϕ I calculated on Sarrau's theory what values of $a - b$ were required to give the retardation observed in each ring, and obtained as follows:—

ϕ	15° 14′	18° 21′	23° 16½′	28° 7½′	32° 7′	35° 34′	38° 36′
$a - b$ ...	·0037916	·0037922	·0037927	·0037931	·0037939	·0037932	·0037936

The observations on the plate cut parallel to the axis gave—

ϕ	53° 58′	57° 11′	64° 45′	72° 13′	79° 53′	83° 40′	85° 37
$a - b$ ...	·0037949	·0037947	·0037945	·0037944	·0037943	·0037946	·0037944

The observations were taken in the Cavendish Laboratory, Cambridge, during the months of March and June, 1885.

For full details as to the apparatus, the plates of quartz used, the mode of observation, the precautions necessary, the temperature effects, and the calculations, reference must be made to the paper.

Edinburgh

Royal Society, December 7.—Mr. J. Murray, Ph.D., Vice-President, in the chair.—Sir W. Thomson read a paper on certain cases of motion of a liquid filling an ellipsoidal hollow; and a paper on the communication of motion from a liquid to a rigid containing shell. He showed that the motion of a liquid when rotating about the long axis of a prolate spheroid is essentially unstable, so that no great speed of rotation can be got up in the liquid in this case by making the containing shell rotate about the long axis.—Prof. Turner showed that the relative length and breadth of the sacrum may be taken as a test of development in different races of mankind. In the higher races the length exceeds the breadth.—Prof. Crum Brown read a paper on a case of interlacing surfaces. In this paper he extended the problem of the locking of threads to surfaces, pointing out that only certain surfaces can be covered over by such an interlacing system. For example, the sphere cannot be so covered, while the cylinder and anchor-ring can.—Prof. Tait communicated an elementary examination of the laws of collision of two systems of spheres, showing as clearly as possible what assumptions are necessary in obtaining average results, and how they are justified. The case in which one system of spheres gains energy from without, while the other loses to external objects, is investigated, and shows that the final average energy is not the same in the two systems, thus affording an escape from the difficulties raised by Botzmann's theorem.—In a second paper Prof. Tait defined the mean free path as the average of the free paths at any moment being described by all the particles. The definition, as usually given, is the average speed of a particle divided by the average number of collisions per particle per second. When the former definition is employed, the factor by which the mean free path is reduced in consequence of the motion of the other particles, is found to be 0·68 nearly, instead of 0·71 nearly, as found from the second definition.

Royal Physical Society, November 18.—Mr. B. N. Peach, the retiring President, delivered an address on some of the relations of Palæontology to Geology, illustrated chiefly by examples from the Scottish rocks.

December 16.—Prof. Duns, Vice-President, in the chair.—Prof. Turner, F.R.S., was elected President, and Mr. J. Harvie Brown, Prof. Duns, and Prof. Ewart were elected Vice-Presidents.—The Secretary read a paper by Mr. Robert Kidston, on the species of the genus Palæoxyris, occurring in British Carboniferous rocks.—A paper was read by Prof. Ewart, on the hatching of herring in deep water. Prof. Ewart pointed out that during recent years the herring-fishing had undergone marked changes in several respects:—(1) There had been a great increase in the "take." In 1820 only 450,000 barrels were cured, while in 1885 nearly 1,500,000 barrels were cured. (2) There had been a change in the fishing-ground; the greater number of the fish during the autumn are now caught from forty to sixty miles off shore. (3) The herring captured during the last few years off the east coast during the autumn were much smaller than those captured some ten years ago. The herring having, to a great extent, deserted the spawning-grounds in the Moray Firth, it was feared that the shoals might diminish in numbers, owing to the ova being unable to develop on the deep off-shore banks. A reference to the charts showed that the North Sea was, on the whole, very shallow—the fifty-fathom line running from fifty to thirty miles from the coast—and that there was only one small area (off Fraserburgh) where there was 100 fathoms of water. By depositing artificially-fertilised eggs in ninety-eight fathoms of water in Lochfyne, off Tarbert, it was proved that the ova develop normally, and that the only difference is one of time, the hatching being delayed owing to the lower temperature of the deep water. It was pointed out further that there was abundance of food for the fry in the off-shore waters of the Moray Firth, and that the fry, on the second day after hatching, were able to ascend at the rate of 100 fathoms in five hours.—A communication was read from Mr. A. Smith on the sucker fishes, Liparis and Lepadogaster.—Mr. Brook called attention to a peculiar method of cell-division in the early segmentation stages of fish ova. A series of vacuoles form in the plane of cleavage either at the surface or in the interior of the cell-protoplasm. By an increase in the size of these vacuoles, the two new cells become separated. Several cells may, however, remain connected together by bridge-like strands of the cell-plasma. This method of cell-division has been observed in Salmonidæ and Gadidæ, but most distinctly in the herring.—Mr. Gulland read a paper on the sense of touch in Astacus, in which he described the distribution and nature of the tactile setæ and their corresponding nerve end-organs, and discussed their origin and relations, and also the nature of certain glands in the great claw.

Mathematical Society, December 11.—Dr. R. M. Ferguson, President, in the chair.—Prof. Tait communicated a paper, which was read by Mr. William Peddie, on integrals occurring in the kinetic theory of gases. Mr. Peddie explained a method of breaking up a rectangle to form a square, and gave the first part of a paper on the theory of contours, and its application to physical science.

SYDNEY

Royal Society of New South Wales, September 2.—Prof. Liversidge, F.R.S., President, in the chair.—Mr. J. P. Josephson, A.M.I.C.E., read a paper on the history of the floods in the Hawkesbury. A number of chromogenic and pathogenic micro-organisms were exhibited and described by W. Camac Wilkinson, M.D. Lond.—An advanced copy of a work containing a series of photographs and descriptions of a case of variola occurring at the Quarantine Station was shown by Dr. J. Ashburton Thompson.—A number of microscopical slides, mounted without pressure, were shown by Mr. H. Sharp, of Adelong.

PARIS

Academy of Sciences, December 21.—M. Jurien de la Gravière, Vice-President, in the chair.—Allocution on the progress of science during the past year, by the Vice-President. —Prizes awarded during the year 1885:—Geometry: Bordin prize to M. P. Appell (2000 fr.) and M. Otto Ohnesorge (1000 fr.); Francœur prize, M. Emile Barbier. Mechanics: Extraordinary prize of 6000 fr. to M. Hélie (2000 fr.) and MM. Hugoniot, Doneaud du Plan, Hatt, and Lucy (1000 fr. each); Poncelet prize to M. Henri Poincaré; Montyon to M. Amsler-Laffon; Plumey to MM. Bienaymé and Daymard; Dalmont to M. Lucas; Fourneyron to M. Colladon. Astronomy: Lalande prize to M. Thollon; Valz to M. Spörer; Bordin to M. Edlund; Lacaze to M. Gernez. Statistics: Two prizes to MM. de Pietra Santa and Keller. Chemistry: Jecker prize to MM. Prunier and Silva (4000 fr. each) and M. G. Rousseau (2000 fr.). Geology: Delesse prize to M. Lapparent. Botany: Barbier prize to MM. Dubois, Heckel, and Schlagdenhauffen; Desmazières to M. Leclerc du Sablon; Montagne to M. Patouillard. Anatomy and Zoology: Grand prize of the Physical Sciences to M. Joannès Chatin; Da Gama Machado to M. Girod. Medicine and Surgery: Montyon to MM. Charpentier, Farabeuf, Regnauld, and Villejean (2500 fr. each), Bréant to M. Mahé; Godard to M. Desnos; Lallemand to M. Grasset. Physiology: Lacaze prize to M. Duclaux; Montyon to M. Remy. Physical Geography: Gay prize to Capt. Defforges. General prizes: Montyon (industries injurious to the health) to MM. Girard and Chamberland (2500 fr. each); Cuvier to M. Van Beneden; Trémont to MM. Bourbouze and Sidot (1000 fr. each); Gegner to M. Valson; Petit d'Ormoy (Mathematical Sciences) to M Halphen; Petit d'Ormoy (Natural Sciences) to M. Sappey; Laplace to M. E. G. A. Coste.—Prizes proposed for the year 1886:—Geometry: A study of the surfaces admitting all the symmetrical planes of one of the regular polyhedrons (3000 fr.); Francœur prize, The work most conducive to the progress of the pure and applied mathematical sciences (1000 fr.). Mechanics: Extraordinary prize of 6000 fr. for any work tending most to increase the efficiency of the French naval forces; Montyon (700 fr.), Invention or improvement of instruments useful to the progress of agriculture, of the mechanical arts or sciences; Plumey (2500 fr.), Improvement of steam-engines, or any other invention contributing most to the progress of steam navigation; Dalmont (3000 fr.), The best work by any of the Ingénieurs des Ponts et Chaussées in connection with any section of the Academy. Astronomy: Laland prize (gold medal worth 540 fr.), for the most interesting observation on work most conducive to the progress of astronomy; Damoiseau (10,000 fr.), Best work on the theory of Jupiter's satellites, discussing the observations and deducing the constants contained in it, especially that which furnishes a direct determination of the velocity of light; Valz (460 fr.), for the most interesting astronomical observation made during the course of the year. Physics: Grand prize of the Mathematical Sciences (3000 fr.), for any important improvement in the theory of the application of electricity to the transmission of force. Statistics: A prize of 500 fr. for the best work on the statistics of France. Chemistry: Jecker prize (5000 fr.), for the work most conducive to the progress of organic chemistry. Geology: Vaillant prize, on the influence exercised on earthquakes by the geological constitution of a country by the action of water or of any other physical causes. Botany: Barbier prize (2000 fr.), for any valuable discovery in the medical and botanical sciences bearing on the healing art; Desmazières (1600 fr.), for the best or most useful work, by a Frenchman or a foreigner, on the cryptogamic plants. Anatomy and Zoology: Savigny prize (975 fr.), for the best work on the invertebrate animals of Syria and Egypt. Medicine and Surgery: Bréant prize (100,000 fr.), for an efficacious remedy against cholera,—discovery of the true causes of Asiatic cholera, with a view to its suppression, or for the discovery of any certain prophylactic against cholera. Physiology: Montyon prize (750 fr.), for the best work on experimental physiology. Physical Geography: Gay prize (2500 fr.), researches on the differences of sea-level in the vicinity of the continents due to local attraction or relief of the land, with examples illustrating the reality of this phenomenon. General prizes: Montyon prize, for any discovery useful to the healing art or tending to render unhealthy industries less injurious; Delalande-Guérineau prize (1000 fr.), for any French traveller or any naturalist who shall have rendered the greatest service to France or to science; Jerome Ponti prize (3500 fr.), for any work judged most useful for the advancement of science. Competitors for these prizes are reminded that all papers must be sent in before June 1, 1886, and that no documents will be returned by the Academy. Copies, however, may be procured through the Secretary.

BERLIN

Physiological Society, Nov. 13.—Prof. Munk reported on experiments carried out by Dr. Ziehen in his laboratory, with a view to deciding the question whether epileptic convulsions, artificially induced by electric stimulation of the brain, proceeded from the cerebral cortex or from centres of deeper situation. By weak electric stimulation of a motory region of the cortex continued for a longer time, or by a stronger stimulation for a shorter time, it was found, after removing the electrode, that convulsions originated in the muscles corresponding with the stimulated region, thence propagating themselves gradually over the whole body. After the stimulation of one region of the cortex, a cause of convulsion was accordingly left in it, gradually overtaking the other centres of the groups of muscles. The question was, whether this propagation of the cause of convulsion took place in the cortex, where, map-like, were situated, adjacent to each other, the regions for the muscles of the eyes, ears, face, anterior and posterior extremities—or whether the propagation got transferred directly to the deeper centres of the muscle sections, gradually taking possession of them. This problem Prof. Luciani endeavoured to solve by exciding a centre of muscle groups out of the cortex, such as that of the anterior extremity, and then causing the convulsive fit artificially. The result he found was that all the muscles gradually fell into a state of convulsion, with the exception of those of the anterior extremity. This experiment, apparently settling the question, had been confirmed by some physiologists, but not by others, so that it became necessary to institute experiments afresh. Dr. Ziehen had now made the observation that under sufficiently long application of weak stimulations the convulsion ensuing and gradually spreading over the whole body was a clonical one, and that under moderately strong stimulation tetanic allied themselves to the clonical spasms, while under very strong stimulations the tetanic contractions preponderated. When, in accordance with Prof. Luciani's procedure, he had excided a region of the cortex and then applied stimulation by weak currents, the clonical spasms showed themselves in all groups of muscles, with the exception of those corresponding with the excided portion of the cortex. When, on the other hand, he applied stimulation by strong currents, he observed the tetanic convulsions assert themselves at those parts likewise of the body, the cortex region of which had been excided, even if weaker at this latter part than in the other muscles. From this result the speaker inferred that the spasmodic stimulation, in the case of clonical contractions, propagated itself in the cortex, and that in the case of tetanic contractions the spasmodic stimulation propagated itself in the deeper parts of the brain. In support of this inference Prof. Munk adduced the succession of the groups of muscles overtaken by spasm. The position of the motory centres in the cortex was precisely known, whereas the local distribution of the deeper centres was unknown. Now, the clonical spasms proceeding from the spot of excitation followed each other precisely in that succession in which the centres of the cortex arranged themselves conterminously, while the succession of tetanic spasms formed a different and irregular series. Further evidence in support of the conclusions just stated was afforded by the following experiment. A region of the cortex having been stimulated by weak currents sufficiently long to induce clonical spasms in the muscles corresponding therewith, and in the muscles belonging to the adjacent region, the part of the cortex first affected was excided. The consequence was that the spasm now propagated itself no further, but ceased entirely. In the case, however, of tetanic spasms, the excision of the stimulated part of the brain had no effect. In refutation of the objection that might possibly be urged, namely, that in the main experiment the excision of a determinate part of the cortex was followed by an exemption from spasms in the group of muscles belonging to that part, for the reason that the excision caused a stimulation which induced a counteracting excitation in the muscles in question, Prof. Munk adduced the fact that he had observed the same result in animals that had been tested in this manner eight months after the excision, when there could no longer be any question as to a stimulation in the part where the excision had been made.—Prof. H. Munk next communicated the observations he had made on pigeons from which he had cut out the corpora striata. The conditions in respect of the corpora striata were very different in birds from those obtaining in Mammalia, seeing that in the brain of birds the corpora striata composed the main mass, whereas in the brain of the Mammalia they retired considerably into the background. If these were now removed on both sides from pigeons, the pigeons yet acted altogether normally, and the functions of all their senses continued unimpaired. With careful attention for a length of time three deviations from the normal state could yet, however, be remarked. The back of the pigeons was curved strongly convex; they never perched either by day or by night; and could never snap up a pea, however much exactness they showed in pecking at any pea laid before them, seeing that in pecking they never opened the beak. The animals had therefore to be fed artificially. In consequence of these observations Prof. Munk conjectured that the corpora striata were the seat for the combination of movements. —Following up this subject Dr. Lehmann stated some provisional results which, in conjunction with Dr. Baginski, he had found in rabbits, in which the corpora striata had been injured. The phenomena resulting under like conditions in pigeons had not been observed. The investigation in this field was still being continued.—Prof. Liebreich gave a short sketch of a series of investigations which had engaged him for some years, and had led to the introduction of a new substance into the pharmacopœia. He premised that the denomination "fats" would have to cover more than it had hitherto done, and not merely such substances as were capable of decomposition in fatty acids and glycerine. All substances, on the contrary, would have to be conceived of as neutral fats, which contained sebacic acids, no matter with what organic base these were combined. Such a neutral fat was discovered by Herr E. Schulze, in 1869, in the yolk of the fleece of sheep, and which consisted of a sebacic acid and cholesterine. This cholesterine fat of sheep's wool, or "lanoline," had been studied by Prof. Liebreich, as to the method of obtaining it on account of its excellent qualities in the way of a salve constituent; it was now being extracted from woollen hairs by means of a centrifugal machine and had become an article of trade. Prof. Liebreich had next investigated the origin of this cholesterine fat, and, with the help of the uncommonly sensitive cholestol reaction of Prof. Liebermann, had come to the conclusion that the cholesterine fat contained in the yolk of sheep was derived neither from the sudorific glands nor from the sebaceous glands, nor from the sebaceous texture of the under-skin, but was seated exclusively in the hairs and in the epidermis cells. This fact led, on the one hand, to the production of the substance as a kind of manufacture, while on the other hand it induced a very extensive series of experiments respecting the distribution of cholesterine fat in the animal kingdom. The speaker found it in the epidermis, the hairs and nails of men, in the hairs of all Mammalia he had examined, in the hoofs of horses, in the paws of swine, in the horns of cattle, in the prickles of the hedgehog, in the feathers of fowls, geese, and a large number of other birds, in the plated sheaths of the tortoise; in short, in all horned textures which, with long and toilsome labour, he had examined. The speaker had, in addition, found the cholesterine fat in the kidneys and the liver of Mammalia; yet it was not beyond question that in these organs the cholesterine fat did not proceed from the blood, in which it was always present in small quantities. It might be conjectured that it would likewise be found in the intestinal canal, and generally wherever epithelial cells occurred. The constant presence in all epithelial formations of a particular fat, which was there formed in the keratine cells, rendered it highly probable that the hairs of the Mammalia and the feathers of birds owed their elasticity and pliancy not, or at all events not exclusively, to the secretion of the sebaceous or caudal glands, but to the cholesterine fat generated in the horn cells themselves. The quality possessed by cholesterine fat of not oxidising, or oxidising only under very rare conditions, rendered it, as was very readily conceivable, most peculiarly adapted for lubricating the skin and feathers. Beyond the property of not becoming rancid, lanoline possessed a whole series of other advantages distinguishing it quite peculiarly as a salve constituent. It absorbed, for example, 100 per cent. of water, and by so doing became a soft substance easy to the touch, penetrating the skin with altogether extraordinary facility, and after but a short rubbing into the cutis, disappeared from view. Prof. Liebreich had already prepared into salves a great number of medicamental stuffs by means of "lanoline," and had made experiments with them which yielded entirely satisfactory results. Lanoline, dark brown in a dry state, grew pale like wax in light, and showed other qualities besides assigning it a place between the ordinary glycerine fats and the wax kind of fats.

STOCKHOLM

Academy of Sciences, November 11.—The following papers were read and accepted for publication in the Society's *Journal*:—Lois de l'équilibre chimique dans l'état dilué, gazeux, ou dissous, by Herr J. H. van't Hoff.—Recherches sur les réactions chimiques dans le champ du microscope, by Prof. E. G. Fatigoti, of Madrid.—Some remarks and experiments on filtration, with reference to its bearing upon the process of transudation in the animal body, by Drs. R. Tigerstedt and G. Santesson.—*Hæmatodeptes terebellidis*, une nouvelle Annélide parasitique de la famille des Euniciens, by Prof. A. Wirén.—On the constitution of some derivatives of naphthaline, by Dr. A. G. Ekstrand.—On combinations of phenyl-textra-zol, by Herr J. A. Bladin.—On the integration of the differential equations of the intermediate orbits, by M. C. V. L. Charlier.

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THURSDAY, JANUARY 7, 1886

THE RACES OF BRITAIN

The Races of Britain; a Contribution to the Anthropology of Western Europe. By John Beddoe, M.D., F.R.S., &c. (London: Trübner; Bristol: Arrowsmith. 1885.)

BELIEVING that after thirty years of labour his opportunities for observation are not likely to add much to his store of facts, or materially alter their significance in his own eyes, Dr. Beddoe has brought together his numerous contributions to the ethnology of the British Isles, and, with the addition of much new matter, has arrayed them before us in such a manner as to show his own conclusions, and to form "some small part of a solid platform" whereon future anthropologists, with antiquaries and philologists, may ultimately build a more complete and certain structure.

Dr. Beddoe's mode of procedure is to make extensive observations on the physical characters of the present inhabitants of our islands, and on those of the adjoining parts of the Continent which are the reputed cradles of the various elements of our race, and to compare the results with the records of history as far as they are available. The physical characters to which he attaches most importance are colour of hair and eyes, head-form, and stature, and of these he has collected a very large number of observations on a systematic plan, and hence the "numerical method" of studying anthropology which he first inaugurated in 1853, and which has since been largely followed by continental observers. Dr. Beddoe attaches most importance to colour, because he believes that "the colour of the hair is so nearly permanent in races of men as to be fairly trustworthy evidence in matters of ethnical descent; and that nearly as much may be said for the colour of the eyes." With regard to head-form he complains of the great dearth of measurements of modern British skulls, the skulls in our museums being chiefly those of criminals, lunatics, and paupers, and therefore of little value; and he finds from personal experience that the accurate measurements of living heads are alike difficult to make and to obtain. He supplies tables, however, of a considerable number of measurements of heads obtained by himself or his friends in different parts of the country. The statistics of stature and weight collected by Dr. Beddoe have been dealt with in a separate essay, and as they were incorporated with others of a similar kind collected by the Anthropometric Committee of the British Association, and published in their final report for 1883, they are, therefore, not republished in his present volume.

It is to his extensive observations on the colour of the hair and eyes that Dr. Beddoe chiefly trusts for his analysis of the racial distribution of our existing population, and for the purpose of more convenient and definite comparison he adopts a formula which serves as an "index of nigrescence." Having classified the colour of the hair as red (R), fair (F), brown (B), dark (D), and black (N), "the gross index," he says, "is gotten by subtracting the number of red and fair-haired persons from that of the dark-haired, together with twice the black-haired. I double the black, in order to give its proper value to the greater tendency to melanosity shown thereby; while brown (chestnut) is regarded as neuter, though most persons placed in Class B are fair-skinned, and approach more nearly in aspect to the xanthous than the melanous variety:—

$$D + 2N - R - F = \text{index.}$$

From the gross index, the net, or percentage index, is of course easily obtained."

Dr. Beddoe is quite alive to the want of uniformity in the manner of observing, to the different significance of the terms employed for the colours of hair and eyes, and to peculiarities in observers themselves, but as the data he makes use of were collected by himself, the personal equation of the observer and the terms employed are constant. He does not explain the principle on which his classification of colour of hair and eyes, is based, and it would seem to be the result of combinations which his very extensive observations have suggested as the most constant and consistent with each other and with other physical characters, as he claims for it a closer appositeness for defining racial distinctions than other schemes. It differs from the plans of Virchow, Vanderkindere, and Kollmann, and other continental anthropologists, and from that of the Anthropometric Committee, which is based on the simple anatomical arrangement of pigment in and on the surface of the iris, hair colour being deemed of secondary importance both from the difficulty of diagnosis and its greater changeableness with age.

Dr. Beddoe's account, extending over eleven chapters, of the prehistoric races, and the various conquests of the Romans, Anglo-Saxons, Danes, and Normans, and the fresh blood which they introduced into the country, is very fully and impartially rendered. The natives of South Britain at the time of the Roman conquest, according to Dr. Beddoe, "consisted mainly of several strata, unequally distributed, of Celtic-speaking people, who in race and physical type, however, partook more of the tall blond stock of Northern Europe than of the thick-set, broad-headed, dark stock which Broca has called Celts. . . . Some of these layers were Gaelic in speech, some Cymric; they were both superposed on a foundation principally composed of the long-headed dark races of the Mediterranean stock, possibly mingled with fragments of still more ancient races, Mongoliform or Allophylian. This foundation-layer was still very strong and coherent in Ireland and the north of Scotland, where the subsequent deposits were thinner, and in some parts partially or wholly absent . . . no Germans, recognisable as such by speech as well as by person, had as yet entered Britain."

Dr. Beddoe appears to hold a middle place between the writers who believe, on the one hand, in the extermination of the native races by the Anglo-Saxons, and on the other in their extensive survival in all parts of the country; while he attaches more importance to the new blood introduced by the Danes and Normans than is commonly admitted.

The portion of the work devoted to an analysis of the racial elements of the present inhabitants of the British Isles and adjoining countries of Western Europe consists of a very large number of tables showing the distribution of the colour of hair and eyes according to the "index of nigrescence," and to a less extent to the head-forms, from the author's personal observations; and of second series of colour of hair and eyes of military deserters illustrated by maps constructed on the plan of the Anthropometric Committee. There are also tables showing the relation between complexion and disease collected at the Bristol Infirmary; and numerous illustrations are given showing the physiognomy of males and females which the author believes to be typical of the various racial elements at present surviving among us.

Of the conclusions which Dr. Beddoe draws from all these observations it is impossible to give a summary here. He examines the whole country, district by district and county by county, from the Shetlands to Cornwall, and the reader must consult the work itself to see how far the author has succeeded in the task he has set himself, and to what extent he has prepared a solid platform for his successors in the same field of inquiry. It is most probable that Dr. Beddoe's conclusions, based as they are on a minute acquaintance with the history of the conquests and settlements of the country, and on a wide personal survey of the population in most stationary situations, will be accepted by anthropologists as the best results and the nearest approach to the truth which is attainable at the present day. On the other hand it is doubtful whether Dr. Beddoe's confidence in colour as a permanent racial character will bear the test of future inquiry, and whether his method will be accepted as sufficient when the questions of prepotency of stock, relative viability of dark and blond persons, and the influence of sexual selection have been more completely investigated. The Jews of Europe are isolated and preserved as a separate race by the sterility or low fertility of their mixed marriages, and the question of hybridism in the human race has received little attention from anthropologists. The function of reproduction is the most highly specialised and the most easily disturbed, and it is probable that the dying out of races is due more to this cause than to the "vices of civilisation" to which they are commonly attributed. American statistics show that the blond type is more subject to all the diseases, except one (chronic rheumatism), which disqualify men for military service, and this must obviously place blonds at a great disadvantage in the battle of life, while the popular saying, "a pair of black eyes is the delight of a pair of blue ones," shows that sexual selection does not allow them to escape from it. It is more than probable, therefore, from all these considerations, that the darker portion of our population is gaining on the blond, and this surmise is borne out by Dr. Beddoe's remark that the proportion of English and Scotch blood in Ireland is probably not less than a third, and that the Gaelic and Iberian races of the west, mostly dark-haired, are tending to swamp the blond Teutonic of England by a reflex migration—a fact not without significance to others than anthropologists at the present time.

The "Races of Britain" gives a very imperfect idea to those who are unacquainted with such inquiries, of the labour, time, and thought expended on its production, but anthropologists who know how to estimate such work at its full value will welcome it with great satisfaction as the most exhaustive account of the ethnology of our country which has appeared in recent years.

CHARLES ROBERTS

OUR BOOK SHELF

Journal of the Royal Agricultural Society. Vol. 21, Part II., Series II. (London: John Murray, 1885.)

THE second part of the current number of this *Journal* opens with the second instalment of Mr. Fream's report upon Canadian agriculture. The climate, soil, and products of Eastern Canada, comprising the better-known States of Ontario, Quebec, and the maritime provinces, are chiefly dealt with, whereas, in the first report, prairie farming, and the almost untrodden regions of the north-west were particularly dealt with. The principal object of the report is to show the capabilities and rapid progress of Canada, and this is achieved by numerous statistics as to production and exports. In these provinces the first fertility of the soil has been in a great degree exhausted, and as a consequence mixed farming with the maintenance of live stock, and the use of improved processes, is taking the place of consecutive corn-growing. The growth of the dairy industry is a remarkable fact, and in the management of their cows and the manipulation of the products of the dairy, more attention is apparently paid to the teachings of science than is usual in the mother country. The exports of cheese have increased from 6,000,000 pounds per annum in 1870, to 76,000,000 pounds in 1884. The butter trade has long been stationary, owing to the uncertain demand for Canadian butter. The Canadian cattle trade has also increased by leaps and bounds from a gross number of 6940 head in 1877, to 61,843 in 1884. The report is full of details of personal experience gained from many settlers in all parts of Old Canada. Names and addresses of the principal farmers, dairymen, and stock-breeders, are given with great frequency, and confer a special value on the report as a guide to intending settlers.

A large portion of the *Journal* is occupied with official reports of the Preston meeting of the Society (1885), including the report upon the prize farms in Lancashire. These last reports are less interesting than usual to practical men, as the Lancashire farmers are exceptionally placed, and conduct their business upon suburban principles of management. The sale of farm produce directly to the town consumer and the carrying back of town manure is the marked feature. Rents appear to range particularly high for the present depressed state of trade and agriculture, and are generally from fifty to sixty shillings per acre.

The customary reports of the Steward upon live stock and implements, and short memoirs of the late Sir B. T. B. Gibbs and Sir Watkin W. Wynn, close this section. A summary of the Commission's Report on Technical Education, 1884, and a reprint from the Report of the Pennsylvania State Board of Agriculture, 1883, occupy some fifty pages, the latter reviving M. Guénon's curious theory with regard to indications of milking properties in the peculiar distribution of hair on the buttocks, known as the "escutcheon."

Among original articles indicating research, those of Miss E. Ormerod on the ox-warble and the warble maggot, of Prof. Robertson upon rickets in sheep, and of Mr. Clement Stephenson upon abortion in cows may be mentioned. Lastly, the number contains a contribution from Rothamsted upon the valuation of unexhausted manures, in which the results of past experiments are brought to bear upon the claims of outgoing tenants for compensation under recent Acts of Parliament.

From Paris to Pekin over Siberian Snows. By Victor Meignan. Edited, from the French, by William Conn. (London: W. Swan Sonnenschein and Co., 1885.)

THE mode in which this volume has been produced is rather curious. In 1873 M. Meignan, who had already travelled in the regions around the Levant for pleasure, took it into his head that, by way of contrast to these lands of the sun, he would like to see a land where snow and ice were predominant, and accordingly he undertook to travel from France to China through Siberia. He appears to have had no object in the journey but the pleasure of motion and of seeing new and strange objects. It was undertaken in the winter, and the traveller naturally saw, and was interested in, Moscow, Nijni-Novgorod, the Urals, and so travelled through Siberia by Omsk to Irkutsk. After a short stay in the latter place he pursued his journey through Kiachta, Urga, and Kalgan to Pekin. Many travellers have done the journey before and since; it is a long and tedious one, and perhaps that is as much as can be said for it. Mr. Conn talks of crossing "the trackless Desert of Gobi" on the way, but this is an abuse of language. The only part of the Gobi passed is that between Urga and Kalgan, two considerable trading cities, between which caravans, couriers, and travellers go daily along a high road which is a very good one as roads go in Asia. But M. Meignan, having done the journey, and being of a lively and amusing turn, wrote an account of it some time after his arrival in France. This account of a journey in 1873 Mr. Conn has "edited" in 1885; he has, he says, produced a modified version rather than a translation, the modifications consisting in correcting the slipshod style of the original, in producing "a more just co-ordination of parts and subordination of minor details," and also in expanding the original here and there. The volume, notwithstanding this dual authorship, is pleasant reading, much as a tolerably written account of a journey in Wales or Scotland would be pleasant. There are not a few errors, especially as the traveller gets farther east, but these cannot seriously interfere with such enjoyment as may be derived from a perusal of the volume. As Mr. Conn has a taste for this species of literary work—having published another volume, an adaptation or translation of a Japanese tale by a French writer, during the year—we would suggest to him that he should select his originals more carefully. A sterling popular work in French or German might very easily prove a sterling popular work in English; there can be little real use in reproducing trumpery French books in English, except to add to the already enormous mass of similar indigenous literature in England.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Iridescent Clouds

ON December 29 just passed, at 3.40 p.m., or shortly after sunset, and during the late frosty storm, there was a brilliant repetition of the iridescent clouds concerning which I wrote to NATURE about a year ago. The tendency of many of these little clouds, or cloudlets, to rectilinear rhomboidal forms was remarkable; also their confinement in point of colour to blue, violet, rose-pink, and green—eschewing yellow, orange, and vermilion reds: while the sunset sky below them was, on the contrary, a gorgeous panorama of all those yellow-*cum*-red partaking colours.

That so good an example of these iridescent cloudlets is not very frequent may be concluded from the number of letters which this occasion has already produced in the *Scotsman* newspaper here, and of which I send you six.

C. PIAZZI-SMYTH

15, Royal Terrace, Edinburgh, January 1

Peculiar Meteorological Phenomenon.—A somewhat rare phenomenon was observed at Burntisland, Falkirk, Laurencekirk, and many other parts of Scotland yesterday. A large number of miniature rainbows presented themselves in the sky, with the red, orange, yellow, and green colours distinctly discernible. They were not larger than the ordinary sun as it appears to the naked eye, and, after remaining visible for a considerable time, gradually faded away.

Fraserburgh, December 28, 1885

SIR,—To-day, at 3 p.m., a heavy snowstorm from the west-north-west was just clearing off here. Along the horizon, from west to south-west, lay a heavy bank of storm-cloud, hiding the sun. Above this, in same general direction, was a belt of clear sky. Above that, as the rack drifted off to south-east, there was disclosed a belt of light cirro-stratus cloud, in same general direction, about 30° from the sun, and evidently at very great height, for it kept the same general position nearly an hour, though with considerable variation of form. When first visible it was fringed on the side next the sun with bands of the most vivid and delicate prismatic colours—in series, blue end outside and red (prolonged into a splendid band of violet) inside. Detached portions, however, had the bands all round. The appearance continued in its first splendour only a few minutes, but less vividly for some time longer. It would be interesting to know whether the same appearance was seen at other places; and, if so, at what hour, and at what angle from the sun?

W. MACGILL, B.A.

Edinburgh, December 29, 1885

SIR,—I write to ask if any of your readers can give an explanation of a remarkable phenomenon which was visible in the western sky this afternoon. Just after sunset a few thin patches of cirrus clouds not far west of the zenith assumed a rich opal hue, while in others all the colours of the spectrum were beautifully displayed. The appearance of one of these clouds was exactly similar, in fact, to a completed, though, of course, miniature rainbow. This phenomenon continued for some time after the sun had set, and at times the colours could be seen to change rapidly. A cold frosty wind from the north-west was blowing at the time. C. M.

Maxton, December 30, 1885

SIR,—With reference to the two letters on this subject in to-day's *Scotsman*, it may interest you to know that the cloud phenomenon in question was witnessed here twice yesterday. About 8 a.m. the sky was perfectly clear, and the crescent moon was shining in the south-west. As the radiance of the sun, as yet beneath the horizon, began to appear, several detached clouds, of a semi-transparent, filmy nature, suddenly came into view in the south-eastern sky, which had, a moment or two before, been without a single speck to dim it. These clouds, at first of an indefinable colour, quickly heightened in tone, and the prismatic colours became visible with gorgeous distinctness, increasing in intensity as the sun neared the horizon. The top band was of a peculiar blue, obviously different from the sky field. Beneath was a wave of rich rose-pink, next a cloudy-orange, with light streaks or "watermarks," then a rich mass of deep violet, fading lower into white. There were three large clouds, the upper and lower lines of which were quite level and perfectly parallel, though the edges to the east and west were sharp and ruggedly cut. In the case of one of these clouds the denser part was apparently rhomboidal, but on its eastern side, and connected with it, was an opalescent vapour filling up the space between what I may term the base and the hypothenuse of an angle of about 15°. The base of this incomplete triangle was equal in length to the base of the incomplete rhomboid. The lines were most clearly defined. There were a number of minute cloudlets, some the merest specks, but all showing the same colours that I have mentioned. They did not remain very long in this distinct state. As the sun rose above the horizon they became beautifully opalescent, and their forms began to change in a wavy manner, and in a short time vanished as in ether from that part of the sky. The sun was now at a slight altitude, and when I turned round I saw to my astonishment similar clouds, though the colours were less distinct, in the north-west, where a few minutes previously none were to be seen. These did not last long, though during their short appearance their outlines were very distinct, there at the time being a heavy haze of reddish gray, changing to dusky carmine above the northern horizon. At this time a west wind was blowing with considerable force, but these clouds appeared to be high above the wind, as they were certainly not influenced by it. In mid-air there seemed to be a counter current, as light cirrus cloud-streaks drifted slowly across the zenith from the east. About 4 p.m. the same phenomenon occurred in the west and north-west, the clouds, if anything, being more beautiful than in the morning. They remained for a time after the sun had set. At 5 p.m. the thermometer registered 12° of frost. I trust I have succeeded in a partial way to convey some idea of sky effects so inexpressibly beautiful as to baffle description. I was informed last night that the previous Monday afternoon, as a party of noblemen and gentlemen were returning to Tynehead Station from a day's shooting on the Humbie Estate, in East Lothian, and while a terrific storm of wind and sleet prevailed, there was a sudden rift, through which the party saw a number of clouds of a similar nature to those I have attempted to describe. JOHN THOMSON

Maxton, Wednesday Afternoon

At 3 p.m. we have had a steady fall of snow for four hours.
JOHN THOMSON

Wick, December 30, 1885

SIR,—Your correspondent "C. M." in to-day's paper exactly describes the phenomenon as it was seen here. The cirrus clouds were probably floating at a very high elevation in a stratum of air much below the freezing-point, and their structure thus having undergone some change, the sunlight became decomposed, causing the prismatic display. This theory may or may not be correct, but the end of the cirrus band farthest from the sun lost the colours first, and the end nearest the sun was the last on which a vestige remained after the sun had set. NEMO

Sunderland, December 30, 1885

SIR,—I have just read in to-day's *Scotsman* the letters of your correspondents in Fraserburgh and Edinburgh concerning the atmospheric or cloud phenomena of Monday, 28th. The appearance of the heavens here from 3.30 p.m. was most striking. The sun set in a rich water-glow, and the sky in the west being very free from obscuration, we could notice how the glow deepened as it ascended, until from 20° to 50° it presented a dark crimson or purple. Just above Venus—which was like a silver ball—there were seen some cirro-stratus clouds—bright and luminous—just like illuminations on a dark ground. They were stationary, and retained their shape for a very long time. At their western extremities were seen all the prismatic colours, as if they were encircled with rainbows. These colours were very distinct for half an hour, and then gradually disappeared; but still the clouds remained, and were seen at 5.20—almost in their original position—as bright electric clouds. I have observed the heavens for thirty years, but never saw so beautiful a cloud-display. I think the explanation is that the various strata of the atmosphere retain certain rays of light longer than usual when the sun's light falls at the oblique angle it has in December. These clouds evidently rested in a part of the atmosphere not affected by the disturbances nearer the earth.

D. PATTERSON, M.A.

ON going out at 4.12 p.m. to-day, I saw several remarkable clouds in the west part of the sky, somewhat similar to those described by Prof. Piazzi Smyth and several other correspondents in NATURE, vol. xxxi. pp. 148, 192, 264, 315, 338, 360. These clouds were collected in three groups, about south-west, west, and north-west respectively. Some of them were streaked, and the streaks and longer axes of all the clouds were directed approximately towards the spot where the sun had recently set. At the time when I first saw them, only one of these clouds showed prismatic colours, but I am informed by a friend that a little earlier, about 4 p.m., this was the case with several. As the other two sets showed colours and changes exhibited later on by those in the south-west, I propose to describe the latter alone.

At 4.12 this group consisted of two large clouds and several smaller ones, just above the planet Venus, the centre of the group being at an altitude of about 30°. The uppermost cloud was about 20° in length and 5° in breadth. Its longer axis was directed towards, but slightly above, the point in the horizon where the sun had just set. The west end of the cloud was rounded, almost semicircular, and hazy near the edge. Then followed two or three fringes, also nearly semicircular, showing rather bright prismatic colours, the blue side of each fringe being towards the sun. The coloured fringes occupied about a third of the cloud; the rest of it was bright, with a slightly greenish tinge, as were also the other clouds of this group. The east end was drawn out in striæ parallel to the longer axis of the cloud. Soon after my first seeing them, the prismatic colours began to fade, and by 4.20 were no longer distinguishable, but the clouds themselves were still bright and noticeable. At 4.25 the cloud that had the prismatic fringes became very faint and had now a slight rose-coloured tinge; the others had the same tinge of colour, but remained bright. By this time the striæ at the east end were drawn out in the direction of the length of the cloud, but became gradually fainter, and by 4.27 had disappeared; so that the cloud was now reduced to about half its original length, the remaining part having at the same time become broader, brighter, and of a deeper rose-colour. This colour, however, soon began to fade, and by 4.34 was nearly gone, though there was no apparent diminution of brightness. At 4.41 they were bright and of a grayish-white, almost steel-gray, colour, and continued so for some time. During all the time I watched them (about three-quarters of an hour) this group as a whole was nearly stationary, though the clouds themselves changed considerably in form and slightly in their relative positions. The sky was almost clear, but near the horizon there were some dark, heavy clouds, and at one time (4.25) several of these, driven by a strong wind, passed rapidly below the group above described, partly covering the lowermost. On going out again at 6.20 to watch them, I found that they had all disappeared. I may add that yesterday evening, soon after sunset, the western sky was covered with a rosy flush, reminding one slightly of the wonderful sunsets of two years ago. CHARLES DAVISON

Sunderland, December 28, 1885

YESTERDAY morning (December 29), from about 8.30 to 9 o'clock, a number of very brilliantly-coloured clouds were observed here by myself and others. The weather was cold and frosty, and the sky at the time was clear with the exception of a thick haze round the horizon; a few clouds were thinly distributed over the sky, and these were more or less coloured. The clouds in the south-east had colours rivalling those of the rainbow in intensity. The colours were also distributed in bands, though not in the same order as those of the rainbow. The clouds in the opposite quarter of the sky were smaller, and though unusually bright as regards luminosity the colours were paler than on the other side of the sky. Each cloud also had one uniform tint, a pale green or blue or pink. The more brilliant clouds while fading assumed an appearance similar to these others, some of the bands broadening out, while others disappeared. I saw a beautiful iridescent cloud here at the same hour one morning last December. At that time the phenomenon was generally observed throughout the country, as is evident from the letters which appeared in NATURE (vol. xxxi. pp. 148, 192, 264, &c.). JOHN STEVENSON

Broxburn, December 30, 1885

The Recent Star-Shower

MR. DENNING's letter of December 12 makes me see that I did not put the point which was in my own mind with sufficient clearness in my letters of December 7 and 8.

It was not to coincidences of star-showers with displays of auroræ as to whose true auroral nature there appeared to be no question, that I wished to draw attention, but to the fact that, among the instances to which I referred, of the coincidence of such showers with *aurora-like phenomena*, there were two occasions, and those two occurrences of the same shower, on which there was a notable absence of any magnetic disturbances. The coincidence of such disturbances with auroral displays is, I suppose, so thoroughly established that the notable absence of them on these occasions may fairly be taken to suggest a possibility that the phenomena were not truly auroral. If so, their coincidence with the star-shower becomes more noteworthy.

Rugby, January 5 J. B. HASLAM

A SPLENDID shower of meteors occurred on the night of November 27, 1885. Seen from Ava, near Mandalay, at 10 p.m. mean time of place, the point of emergence was near the zenith, and the shower radiated to each point of the horizon. The rate at that hour was 450 to 600 per minute, as near as I could judge lying on my back on the steamer's awning. It is probable, however, that I missed a great many. The point of emergence was at one-fifth the distance from γ Andromedæ (Almach) towards β Andromedæ (Mirach). The following night the shower was still plentiful, but I did not count them. The nights have been very clear and beautiful here.

December 1, 1885 ALFRED CARPENTER

Deposits of the Nile Delta

IN the abstract of the Report of the Committee of the Royal Society, on recent borings in the Nile Delta (NATURE, Dec. 10, 1885, p. 142), there is a reference to my "Notes on the Geology of the Nile Valley" (*Geological Magazine*, 1884), which calls for some explanation in the interests of Egyptian geology. When I saw a portion of the borings in Cairo, in the early part of 1884, the work had extended to a depth of only about 40 feet. At a depth of between 30 and 40 feet the boring-rod, after passing through continuous Nile mud, had entered into quicksand, consisting of polished and rounded grains of quartz and other hard rocks (desert sand), and the difficulties incident to this material had for the time arrested the operations. In connection with this and with the insufficiency of the funds on hand for overcoming the difficulties of the work, I wrote a letter at the time to the President of the Royal Society, strongly urging an additional grant, in order that greater depths might be reached.

I then believed, and still believe, that the quicksand marks the true base of the modern Delta alluvium, and corresponds with the similar sand which in certain parts of the Delta protrudes itself from beneath the fluviatile deposit. I did not, however, suppose that this sand rests directly on the rocky floor of the valley. On the contrary, as might be inferred from my short statement in the *Geological Magazine* (July 1884, p. 292 and footnote), I anticipated that below the sand would be found the Pleistocene clays, marls, sands, and concretionary limestones of the "Isthmian" formation seen at El Guisr on the Suez Canal, and the equivalents of which rise from under the alluvium in several places on the sides of the Nile Valley. These also constitute the lower strata of the borings reported by Figari Bey; and it appeared to me that in the colour and texture of the sediment mixed with the lower samples of the sand there were indications of the approach to these deposits.

Though I have not seen the borings between 40 and 80 feet, I still think that the question whether these are modern, or belong to the Pleistocene, remains to be disposed of, and will require comparison of the lower samples, if they can be separated from the mud and sand introduced from above, with the overlying deposit. This may have already been attended to, but if so, the fact is not stated in the published abstract. With reference to such comparisons I would ask particular attention to the chemical character and depth of the specimens containing calcareous concretions, which are characteristic of the Isthmian rather than of the Nilotic formation.

Of course I do not affirm that the modern deposit of the Delta is in no place thicker than 40 feet, on the contrary, on my view of the history of the district, there must be old buried channels of the Nile in which it is much thicker, but it should be possible to recognise these by the character of the material filling them.

The softness of the Nile water and the minutely arenaceous character of the Nile mud, as well as the connection of this with its fertility, have been remarked from the most ancient times; and the microscopic details given by Prof. Judd have done much to give precision to our views on these points. With respect however to the causes and geological significance of these phenomena, the conclusions stated in the abstract seem open to serious objections, suggested by the physical features of the area drained by the Nile, and the conditions under which the fluviatile deposits are laid down. As this subject is of some importance both with reference to the geology of Egypt and general geology, I would ask your permission to refer to it in a second short communication. J. WILLIAM DAWSON

McGill College, Montreal, December 24, 1885

The Discovery of the Source of the Mississippi

IT is a matter of little importance or interest in what spot is located the ultimate spring of the longest branch of even the greatest river. Especially is this the case with the Mississippi, where it may easily be an open question which of a dozen branches is the longest, when traced through its innumerable lakes and windings. By common consent, however, a certain branch of the Mississippi has been assumed as the river proper, and its head as Lake Itasca, in northern central Minnesota. The river was explored to this point, and the lake discovered in 1832 by Schoolcraft, who published a map of the lake, and of the river from this point downwards. He spent but one night on the lake, and did not explore its tributaries. Four years later Nicollet led an expedition to the head waters of this stream, reached Lake Itasca, and spent several days in making a thorough exploration of the country about it. In his narrative, published in 1841, he gives a full description of the tributaries to the lake which constituted, according to general acceptation, the extreme head waters of the river. The report is accompanied by a map, on which the geographic features described in the narrative are delineated, and which agrees in general with later and more accurate maps.

During the half century which has passed since the time of these explorers, settlement has crowded upon this region, railroads have been built in close proximity to it, and the country has been explored in every direction in the interest of the lumber industry. Furthermore, in 1876, the surveys of the General Land Office were extended over it. Lines were run at intervals of a mile over the whole region, and every lake and pond of any importance was mapped by traverse survey. In short, the country has long since ceased to be a *terra incognita*.

It is therefore with astonishment, not unmixed with a feeling akin to disgust, that we read in the daily papers, in certain magazines, and finally in the *Journal* of the Royal Geographical Society, an account of the alleged "discovery" of the source of the Mississippi, made by a Capt. Glazier, in the summer of 1881. It appears from his narrative, published in great fulness of detail in the *American Meteorological Journal*, September to December, 1884, that his expedition started at St. Paul and pushed its way manfully by rail and stage to the Leech Lake Indian agency. After obtaining at this place a full complement of men and material (except provisions) for a life in the wilderness, they started westward for Lake Itasca. They fortunately escaped all the perils of the journey, and arrived there on the third day safely. Coasting along the shore of the lake, they found a stream coming in at the head of the south-west arm, up which they journeyed, some two hundred yards, when they entered a second lake, which Capt. Glazier claims to be the ultimate source of the Mississippi, and to which, probably in virtue of his heroic achievement in being paddled to it, he claims the right to give his own name. The failure of provisions prevented him from making any further exploration or discovery, and the expedition returned to settlements.

It appears from the explorer's description and from the extremely incorrect map which accompanies his narrative—made, as he naively informs the reader, from information furnished by his Indian guide—that his so-called Glazier Lake is identical with a lake in Township 143 north, Range 36 west, which had been carefully mapped by traverse survey by the General Land Office in 1876, or five years prior to his "discovery." This lake, or pond, has an area of about half a square mile. On the Land Office plat it is called Elk Lake, and its connection with Lake Itasca is plainly indicated. By a mere inspection of this plat Capt. Glazier might have made his discovery, and thus have avoided all the hardships and labours of his perilous journey. Since his claim to the discovery of this lake must be considered as altogether baseless, his desire that his name shall be for ever associated with it as the source of the Mississippi River is preposterous, especially as he cannot be ignorant of the above facts. HENRY GANNETT

Washington, D.C.

Chætoderma

YOUR biological readers will probably be interested to learn that I dredged a specimen of *Chætoderma* last August off the south end of the Isle of Man from a depth of about 20 fathoms. It is about 1·5 cm. in length, and differs somewhat in shape from both *Chætoderma nitidulum*, Lovén, and the new species (*C. militare*, Selenka) found during the *Challenger* Expedition. The calcareous spicules are also different from those of both the previously described species, but they seem to vary considerably in shape. The specimen—along with the other Vermes obtained during the various dredging expeditions carried on last summer by the members of the Liverpool Marine Biology Committee—has been placed in the hands of Mr. R. J. Harvey Gibson, M.A., for detailed examination, and will be described in the First Report upon the Fauna of Liverpool Bay, to be published shortly. W. A. HERDMAN

University College, Liverpool, December 30, 1885

A Solar Halo

AT about noon on this day a fine halo with its mock suns was well seen at the Radcliffe Observatory. Measurements of the vertical radii of the first circle gave 22° 24′, whilst the angular distance between the true and mock suns was 22° 30′. The radius of the second circle was rather difficult to determine, but the mean of several measures gave 46° 40′. The inverted arcs at the vertices of the two circles were clearly seen. The zenith distance of the sun's centre was nearly 75° at the time of the observation. E. J. STONE, Radcliffe Observer

Radcliffe Observatory, Oxford, December 30, 1885

Ventilation

MR. FLETCHER's letter in your issue of December 17 (p. 153) illustrates the difficulties encountered by people who adopt patent ventilators and so-called systems of ventilation without considering the natural laws ruling the flow of currents of air.

The exit-shafts recommended by the writer of your article on the subject, as he himself confesses, may act as inlets, and generally do, if there is no other free inlet for air. This there seldom is in cold weather when the windows are closed, unless a hot-air grate on the Galton or other model is adopted. There is very little objection to running the exit-tube from the chandelier into the chimney flue, on the same principle as that of the chimney to each ventilator, now so much used.

I think the writer of your article hardly appreciates the difficulties to be encountered in ventilating an English house or assembly-room. Irrespective of the ignorance of the public generally on the subject, we are met by the fact that in most town houses it is very difficult to place a stove, with proper fresh-air inlet, in the entrance, where it may afford a supply of fresh warmed air to the house. As a rule the nearest flue is a very long way off. Again, fire-places being as a rule on inside walls in such houses, the flue to supply a hot-air grate (by far the best method of warming) has to be very long, and there is difficulty in arranging for its due cleansing.

Your correspondent speaks of expense being no object in the erection of public buildings. This is far from my experience. In the cases of churches, schools, and assembly-rooms, the question of ventilation is entirely bound up with that of heating, and in conversation with various makers of heating apparatus I have found their views quite unanimous on the peculiarities of building Committees on this subject. The lowest tender is as a rule accepted, and this never provides for ventilation. They are asked to heat only.

The real objection to ventilation in large rooms is the cost of the necessary heating apparatus. For instance, a large concert-room has recently been erected in this neighbourhood to seat 3800 persons, with a cubical content of 514,800 feet.

Now to warm this in the ordinary manner by hot-water pipes would require about 2600 feet of four-inch piping. But to supply a thousand feet of air per head, heated from 30° to 60° Fahr. would, according to the formula given in Hood's work, require no less than 10,600 feet, or more than four times the amount, while the space occupied by more than two miles of large piping would have to be taken into consideration.

No doubt the heating could be done more economically by steam coils or large stoves if care be taken not to over-heat the air.

Until ventilation is considered as necessary as drainage, and is paid for accordingly, and till failure on the part of architect and builder to secure it is visited with as severe penalties as failure in points of construction or design, I see no chance of improvement on the present state of chaos. ERNEST H. JACOB

Leeds, December 22, 1885

Travellers' Snake-Stories

TRAVELLERS' "stories" are not expected to be quite matter-of-fact. One of the best of these jokes occurs in an article on "Travellers' Snake-Stories" in the December number of *Good Words*. Among the natural enemies of snakes the mongoose is thus described:—

"The mongoose, a bird known as the kingfisher of Australia, and secretary-bird of Africa, is well known in some of the West Indian Islands almost always to come off victorious in its encounters with the rattlesnake, and it has even been proposed to breed it specially for its extirpation."

From the use of the singular number in the above extract it is clear that only one animal is intended to be described, and that one is a *bird*. Next follows an interesting description in considerable detail (quoted from the *Standard* of January 22, 1883), of fights between the *Indian* mongoose and the Indian cobra in Lucknow, ending with the sentence:—

"He adds that these birds make affectionate pets," &c.

This is the best joke of all. It may be that the Australian kingfisher and African secretary-bird are locally called "mongoose" (this is not within the present writer's experience), but the *Indian* mongoose is a small animal, in shape very like a weasel or a ferret. It is impossible that the writer in the *Standard* (who is stated to have himself arranged the mongoose and cobra duels) could have described the mongoose as a *bird*. What does the man mean? ALLAN CUNNINGHAM

Blackbird with White Feather

I NOTICE a letter from Mr. Murphy in your issue of December 24, 1885, about a blackbird with a white feather in its tail. Allow me to say that last month I saw a cock blackbird with a pure white tail; the rest of its plumage was natural. I saw it very distinctly, as it was flying away from me at the time, not more than ten yards off when I first noticed it, with its tail extended; I saw it again last week, within a few feet of the same place, this time running under a gate. My wife says she saw a similar bird, at the same spot, about a year ago. THOMAS J. BUSK

Ford's Grove, Winchmore Hill, January 4

IT may interest your correspondent, Mr. J. J. Murphy, to know that for the last two years we have had a cock blackbird about our garden with a patch of pure white on each side of the head. E. BROWN

Further Barton, Cirencester, January 3

DURING the frost of January 1880 I frequently noticed a hen blackbird with several white feathers on the head, breast, and back. It was quite tame, and came for food every day.

Hartford, Cheshire, December 30, 1885 E. K.

ON THE METHOD OF RECIPROCANTS AS CONTAINING AN EXHAUSTIVE THEORY OF THE SINGULARITIES OF CURVES [1]

IT is now two years and seven days since a message by the Atlantic cable containing the single word "elected" reached me in Baltimore informing me that I had been appointed Savilian Professor of Geometry in Oxford, so that for three weeks I was in the unique position of filling the post and drawing the pay of Professor of Mathematics in each of two Universities: one, the oldest and most renowned, the other—an infant Hercules—the most active and prolific in the world, and which realises what only existed as a dream in the mind of Bacon—the House of Solomon in the New Atlantis.

To Johns Hopkins, who endowed the latter, and in conjunction with it a great Hospital and Medical School, between which he divided a vast fortune accumulated

[1] Inaugural Lecture of Prof. Sylvester, F.R.S., delivered before the University of Oxford, December 12, 1885.

during a lifetime of integrity and public usefulness, I might address the words familiarly applied to one dear to all Wykehamists:—

> "Qui condis lævâ, qui condis collegia dextrâ,
> Nemo tuarum unam vicit utraque manû."

The chair which I have the honour to occupy in this University is made illustrious by the names and labours of its munificent and enlightened founder, Sir Henry Saville; of Thomas Briggs, the second inventor of logarithms; of Dr. Wallis, who, like Leibnitz, drove three abreast to the temple of fame—being eminent as a theologian, and as a philologer, in addition to being illustrious as the discoverer of the theorem connected with the quadrature of the circle named after him, with which every schoolboy is supposed to be familiar, and as the author of the "Arithmetica Infinitorum," the precursor of Newton's "Fluxions"; of Edmund Halley, the trusted friend and counsellor of Newton, whose work marks an epoch in the history of astronomy, the reviver of the study of Greek geometry and discoverer of the proper motions of the so-called fixed stars; and by one in later times not unworthy to be mentioned in connection with these great names, my immediate predecessor, the mere allusion to whom will, I know, send a sympathetic thrill through the hearts of all here present, to whom he was no less endeared by his lovable nature than an object of admiration for his vast and varied intellectual requirements, whose untimely removal, at the very moment when his fame was beginning to culminate, cannot but be regarded as a loss, not only to his friends and to the University for which he laboured so strenuously, but to science and the whole world of letters.

As I have mentioned, the first to occupy this chair was that remarkable man Thomas Briggs, concerning whose relation to the great Napier of Merchiston, the fertile nursery of heroes of the pen and the sword, an anecdote, taken from the Life of Lilly, the astrologer, has lately fallen under my eyes, which, with your permission, I will venture to repeat:—

"I will acquaint you (says Lilly) with one memorable story related unto me by John Marr, an excellent mathematician and geometrician, whom I conceive you remember. He was servant to King James and Charles the First. At first, when the lord Napier, or Marchiston, made public his logarithms, Mr. Briggs, then reader of the astronomy lectures at Gresham College, in London, was so surprised with admiration of them, that he could have no quietness in himself until he had seen that noble person the lord Marchiston, whose only invention they were: he acquaints John Marr herewith, who went into Scotland before Mr. Briggs, purposely to be there when those two so learned persons should meet. Mr. Briggs appoints a certain day when to meet at Edinburgh; but failing thereof, the lord Napier was doubtful he would not come. It happened one day as John Marr and the lord Napier were speaking of Mr. Briggs: 'Ah John (said Marchiston), Mr. Briggs will not now come.' At the very moment one knocks at the gate; John Marr hastens down, and it proved Mr. Briggs to his great contentment. He brings Mr. Briggs up into my lord's chamber, where almost *one quarter of an hour was spent*, each beholding other almost with admiration *before one word was spoke*. At last Mr. Briggs began: 'My lord, I have undertaken this long journey purposely to see your person, and to know by what engine of wit or ingenuity you came first to think of this most excellent help into astronomy, viz. the logarithms; but, my lord, being by you found out, *I wonder nobody else found it out before*, when now known it is so easy.' He was nobly entertained by the lord Napier; and every summer after that, during the lord's being alive, this venerable man Mr. Briggs went purposely into Scotland to visit him."[1]

Some apology may be needed, and many valid reasons might be assigned, for the departure, in my case, from the usual course, which is that every professor on his appointment should deliver an inaugural lecture before commencing his regular work of teaching in the University. I hope that my remissness, in this respect, may be condoned if it shall eventually be recognised that I have waited, before addressing a public audience, until I felt prompted to do so by the spirit within me craving to find utterance, and by the consciousness of having something of real and more than ordinary weight to impart, so that those who are qualified by a moderate amount of mathematical culture to comprehend the drift of my discourse, may go away with the satisfactory feeling that their mental vision has been extended and their eyes opened, like my own, to the perception of a world of intellectual beauty, of whose existence they were previously unaware.

This is not the first occasion on which I have appeared before a general mathematical audience, as the messenger of good tidings, to announce some important discovery. In the year 1859 I gave a course of seven or eight lectures at King's College, London, at each of which I was honoured by the attendance of my lamented predecessor, on the subject of "The Partitions of Numbers and the Solution of Simultaneous Equations in Integers," in which it fell to my lot to show how the difficulties might be overcome which had previously baffled the efforts of mathematicians, and especially of one bearing no less venerable a name than that of Leonard Euler, and also laid the basis of a method which has since been carried out to a much greater extent in my "Constructive Theory of Partitions," published in the *American Journal of Mathematics*, in writing which I received much valuable co operation and material contributions from many of my own pupils in the Johns Hopkins University.[1] Several years later, in the same place, I delivered a lecture on the well-known theorem of Newton, which fills a chapter in the "Arithmetica Universalis," where it was stated without proof, and of which many celebrated mathematicians, including again the name of Euler, had sought for a proof in vain. In that lecture I supplied the missing demonstration, and owed my success, I believe, chiefly to merging the theorem to be proved, in one of greater scope and generality. In mathematical research, reversing the axiom of Euclid, and converting the proposition of Hesiod, it is a continual matter of experience, as I have found myself over and over again, that the whole is less than its part. On a later occasion, taking my stand on the wonderful discovery of Peaucellier, in which he had realised that exact parallel motion which James Watt had believed to be impossible, and exhausted himself in contrivances to find an imperfect substitute for, in the steam-engine, I think I may venture to say that I brought into being a new branch of mechanico-geometrical science, which has been, since then, carried to a much higher point by the brilliant inventions of Messrs. Kempe and Hart. I remember that my late lamented friend, the Lord Almoner's Reader of Arabic in this University, subsequently editor of the *Times*, Mr. Chenery, who was present on that occasion in an unofficial capacity, remarked to me after the lecture, which was delivered before a crowded auditory at the Royal Institution, that when they saw two suspended

[1] A very similar story is told of the meeting of Leopardi and Niebuhr in Rome. What Briggs said of logarithms may be said almost in the same words of the subject of this lecture:—"This most excellent help to geometry which, being found out, one wonders nobody else found it out before; when, now known, it is so easy." I quite entered into Brigg's feelings at his interview with Napier when I recently paid a visit to Poincaré in his airy perch in the Rue Gay-Lussac in Paris (will our grandchildren live to see an Alexander Williamson Street in the north-west quarter of London, or an Arthur Cayley Court in Lincoln's Inn, where he once abode?). In the presence of that mighty reservoir of pent-up intellectual force my tongue at first refused its office, my eyes wandered, and it was not until I had taken some time (it may be two or three minutes) to peruse and absorb as it were the idea of his external youthful lineaments that I found myself in a condition to speak.

[1] In one of those lectures, two hundred copies of the notes for which were printed off and distributed among my auditors, I founded and developed to a considerable extent the subject since rediscovered by M. Halphen under the name of the Theory of Aspects.

opposite Peaucellier cells, coupled toe-and-toe together, swing into motion, which would have been impossible had not the two connected moving points each described an accurate straight line, "the house rose at you." [The lecture merely illustrated experimentally two or three simple propositions of Euclid, Book III.].

The matter that I have to bring before your notice this afternoon is one far bigger and greater, and of infinitely more importance to the progress of mathematical science, than any of those to which I have just referred. No subject during the last thirty years has more occupied the minds of mathematicians, or lent itself to a greater variety of applications, than the great theory of Invariants. The theory I am about to expound, or whose birth I am about to announce, stands to this in the relation not of a younger sister, but of a brother, who, though of later birth, on the principle that the masculine is more worthy than the feminine, or at all events, according to the regulations of the Salic law, is entitled to take precedence over his elder sister, and exercise supreme sway over their united realms. Metaphor apart, I do not hesitate to say that this theory, *minor natu potestate major*, infinitely transcends in the extent of its subject-matter, and in the range of its applications, the allied theory to which it stands in so close a relation. The very same letters of the alphabet which may be employed in the two theories, in the one may be compared to the dried seeds in a botanical cabinet, in the other to buds on the living branch ready to burst out into blossom, flower, and fruit, and in their turn supply fresh seed for the maintenance of a continually self-perpetuating cycle of living forms. In order that I may not be considered to have lost myself in the clouds in making such a statement, let me so far anticipate what I shall have to say on the meaning of Reciprocants and their relation to the ordinary Invariantive or Covariantive forms by taking an instance which happens to be common (or at least, by a slight geometrical adjustment, may be made so) to the two theories. I ask you to compare the form

$$a^2d - 3abc + 2b^3$$

as it is read in the light of the one and in that of the other. In the one case the a, b, c, d stand for the coefficients of a so-called Binary Quantic, and its evanescence serves to express some particular relation between three points lying in a right line. In the other case the letters are interpreted to mean the successive differential derivatives of the 2nd, 3rd, 4th, 5th orders of one Cartesian co-ordinate of a curve in respect to the other. The equation expressing this evanescence is capable of being integrated, and this integral will serve to denote a relation between the two co-ordinates which furnishes the necessary and sufficient condition in order that the point of the curve of any or no specified order (for it may be transcendental) to which the co-ordinates may refer, may admit of having, at the point where the condition is satisfied, a contact with a conic of a higher order than the common. In the one case the letters employed are dead and inert atoms; in the other they are germs instinct with motion, life, and energy.

A curious history is attached to the form which I have just cited, one of the simplest in the theory, of which the narrative may not be without interest to many of my hearers, even to those whose mathematical ambition is limited to taking a high place in the schools.

At pp. 19 and 20 of Boole's "Differential Equations" (edition of 1859) the author cites this form as the lefthand side of an equation which he calls the "Differential Equation of lines of the second order," and attributes it to Monge, adding the words, "But here our powers of geometrical interpretation fail, and results such as this can scarcely be otherwise useful than as a registry of integrable forms." In this vaticination, which was quite uncalled for, the eminent author, now unfortunately deceased, proved himself a false prophet, for the form referred to is among the first that attracts notice in crossing the threshold of the subject of Reciprocants, and is but one of a crowd of similar and much more complicated expressions, no less than it, susceptible of geometrical interpretation and of taking their place on the register of integrable forms. A friend, with whom I was in communication on the subject, and whom I see by my side, remarked to me, in reference to this passage:—"I cannot help comparing a certain passage in Boole to Ezekiel's valley of the dry bones: 'The valley was full of bones, and lo, they were very dry.' The answer to the question, 'Can these bones live?' is supplied by the advent of the glorious idea of the Reciprocants; and the grand invocation, 'Come from the four winds, O breath, and breathe upon these slain, that they may live,' may well be used here. That they will 'live and stand up upon their feet an exceeding great army' is what we may expect to happen." This, as you will presently see, is just what actually has happened.

Not knowing where to look in Monge for the implied reference, I wrote to an eminent geometer in Paris to give me the desired information; he replied that the thing could not be in Monge, for that M. Halphen, who had written more than one memoir on the subject of the differential equation of a conic, had made nowhere any allusion to Monge in connection with the subject. Hereupon, as I felt sure that a reference contained in repeated editions of a book in such general use as Boole's "Differential Equations" was not likely to be erroneous, I addressed myself to M. Halphen himself, and received from him a reply, from which I will read an extract:—

"En premier lieu, c'est une chose nouvelle pour moi que l'équation différentielle des coniques se trouve dans Boole, dont je ne connais pas l'ouvrage. Je vais, bien entendu, le consulter avec curiosité. Ce fait a échappé à tout le monde ici, et l'on a cru généralement que j'avais le premier donné cette équation. *Nil sub sole novi!* Il m'est naturellement impossible de vous dire où la même équation est enfouie parmi les œuvres de Monge. Pour moi, c'est dans *Le Journal de Math.* (1876), p. 375, que j'ai eu, je crois, la première occasion de développer cette équation sous la forme même que vous citez; et c'est quand je l'ai employée, l'année suivante, pour le problème *sur les lois de Kepler* (*Comptes rendus*, 1877, t. lxxxiv. p. 939), que M. Bertrand l'a remarquée comme neuve. Ce qui vous intéresse plus, c'est de connaître la forme simplifiée sous laquelle j'ai donné plus tard cette équation dans le *Bulletin* de la Société Mathématique. C'est sous cette dernière forme que M. Jordan la donne dans son cours de l'École Polytechnique" (t. i. p. 53).

All my researches to obtain the passage in Monge referred to by Boole have been in vain.[1]

I will now proceed to endeavour to make clear to you what a Reciprocant means: the above form, which may be called the *Mongian*, would afford an example by which to illustrate the term; but I think it desirable to begin with a much easier one. Consider then the simple case of a single term, the second derivative of one variable, y, in respect to another, x. Every tyro in algebraical geometry knows that this, or rather the fact of its evanescence, serves to characterise one or more points in a curve which possess, so to say, a certain indelible and intrinsic character, or what is technically called a singularity; in this case an inflexion such as exists in a capital S, or Hogarth's line of beauty.

If we invert the two variables, exchanging, that is to say, one with the other, the fact of this indelibility draws with

1 Search has been made in the collected works of Monge and in manuscripts of his own or Prony in the library of the Institute, but without effect. I have also made application to the Universal Information Society, who undertake to answer "every conceivable question," but nothing has so far come of it. Perhaps until the citation from Monge is verified it will be safer in future to refer to the so-called Mongian as the Boole-Mongian. It may be regarded as the starting-point of the Differential Invariant Theory, as the Schwarzian is of the deeper-lying and more comprehensive Reciprocant Theory.

it the consequence that in general these two reciprocal functions must vanish together, and as a fact each is the same as the other multiplied or divided by the third power of the first derivative of the one variable with respect to the other taken negatively. In this case we are dealing with a single derivative and its reciprocal. The question immediately presents itself whether there may not be a combination of derivatives possessing a similar property. We know that no *single* derivative except the second does.

Such a combination actually presents itself in a form which occurs in the solution of Differential Equations of the second order, the form

$$\frac{dy}{dx}\cdot\frac{d^3y}{dx^3}-\frac{3}{2}\left(\frac{d^2y}{dx^2}\right)^2,$$

which, after the name of its discoverer, Schwarz, we may agree to call a Schwarzian (Cayley's "Schwarzian Derivative"[1]). If in this expression the x and y be interchanged, its value, barring a factor consisting of a power of the first derivative, remains unaltered, or, to speak more strictly, merely undergoes a change of algebraical sign. We may now arrive at the generalised conception of an algebraical function of the derivatives of one variable in respect to another, which, if we agree to pay no regard to the algebraical sign, or to any power of the first derivative that may appear as a factor, will remain unaltered when the dependent and independent variables are interchanged one with another; and we may agree to call any such function a Reciprocant.

But here an important distinction arises—there are Reciprocants such as the one I first mentioned, $\frac{d^2y}{dx^2}$, or such as the Mongian to which allusion has been made in the letter from M. Halphen, in which the second and higher differential derivatives alone appear, the first differential derivative not figuring in the expression. These may be termed Pure Reciprocants. Thus I repeat $\frac{d^2y}{dx^2}$, and

$$9\left(\frac{d^2y}{dx^2}\right)^2\cdot\frac{d^5y}{dx^5}-45\frac{d^2y}{dx^2}\cdot\frac{d^3y}{dx^3}\cdot\frac{d^4y}{dx^4}+40\left(\frac{d^3y}{dx^3}\right)^3$$

are pure reciprocants. Those from which the first derivative $\frac{dy}{dx}$ is not excluded may be called Mixed Reciprocants. An example of such kind of Reciprocants is afforded by the Schwarzian above referred to. This distinction is one of great moment, for a little attention will serve to make it clear that every pure reciprocant expressed in terms of x and y marks an intrinsic feature or singularity in the curve, whatever its nature may be, of which x and y are the co-ordinates; for if in place of the variables (x, y) any two linear functions of these variables be substituted, a pure reciprocant, by virtue of its reciprocantive character, must remain unaltered save as to the immaterial fact of its acquiring a factor containing merely the constants of substitution.[2]

The consequence is that every pure reciprocant corresponds to, and indicates, some singularity or characteristic feature of a curve, and *vice versâ* every such singularity of a general nature and of a descriptive (although not necessarily of a projective) kind, points to a pure reciprocant.

Such is not the case with mixed reciprocants. They will not in general remain unaltered when linear substitutions are impressed upon the variables. Is it then necessary, it may be asked, to pay any attention to mixed reciprocants; or may they not be formally excluded at the very threshold of the inquiry? Were I disposed to put the answer to this question on mere personal grounds, I feel that I should be guilty of the blackest ingratitude, that I should be kicking down the ladder by which I have risen to my present commanding point of view, if I were to turn my back on these humble mixed reciprocants, to which I have reason to feel so deeply indebted; for it was the putting together of the two facts of the substantial permanence under linear substitutions impressed upon the variables of the Schwarzian form and the simpler one which marks the inflexions of a curve—it was, if I may so say, the collision in my mind of these two facts—that kindled the spark and fired the train which set my imagination in a blaze by the light of which the whole horizon of Reciprocants is now illumined.

But it is not necessary for me to defend the retention of mixed reciprocants on any such narrow ground of personal predilection. The whole body of Reciprocants, pure and mixed, form one complete system, a single garment without rent or seam, a complex whole in which all the parts are inextricably interwoven with each other. It is a living organism, the action of no part of which can be thoroughly understood if dissevered from connection with the rest.

It was in fact by combining and interweaving mixed reciprocants that I was led to the discovery of the pure binomial reciprocant, which comes immediately after the trivial monomial one,—the earliest with which I became acquainted, and of the existence of compeers to which I was for some time in doubt, and only became convinced of the fact after the discovery of the Partial Differential Equation, the master-key to this portion of the subject, which gives the means of producing them *ad libitum* and ascertaining all that exist of any prescribed type. Of this partial differential equation I shall have occasion hereafter to speak; but this is not all, for, as we shall presently see, mixed reciprocants are well worthy of study on their own account, and lead to conclusions of the highest moment, whether as regards their applications to geometry or to the theory of transcendental functions and of ordinary differential equations.

The singularities of curves, taking the word in its widest acceptation, may be divided into three classes: those which are independent of homographic deformation and which remain unaltered in any perspective picture of the curve; those which, having an express or tacit reference to the line at infinity, are not indelible under perspective projection, but using the word descriptive with some little latitude may, in so far as they only involve a reference to the line at infinity as a line, be said to be of a purely descriptive character; and, lastly, those which are neither projective nor purely descriptive, having relation to the points termed, in ordinary parlance, "circular points at infinity" [for which the proper name is "centres of infinitely distant pencils of rays," *i.e.* pencils, every ray of which is infinitely distant from every point external to it]. Such, for instance, would be the character of points of maximum or minimum curvature, which, as we shall see, indicate, or are indicated by, that particular class of Mixed to which I give the name of "Orthogonal Reciprocants." All purely descriptive singularities alike, whether pro-

[1] More strictly speaking this is Cayley's Schwarzian derivative cleared of fractions—it may well be called the Schwarzian (see my note on it in the *Mathematical Messenger* for September or October past). Prof. Greenhill in regard to the Schwarzian derivative proper writes me as follows:—

"I found the reference in a footnote to p. 74 of Klein's 'Vorlesungen über das Ikosaëder, &c.,' in which Klein thanks Schwarz for sending him the reference to a paper by Lagrange, 'Sur la construction des cartes géographiques' in the *Nouveaux Mémoires de l'Académie de Berlin*, 1779. Compare also Schwarz's paper in Bd. 75 of *Borchardt's Journal*, where further literary notices are collected together. Klein says further that in the 'Sächsischen Gesellschaft von Januar 1883,' he has considered the inner meaning (*innere bedentung*) of the differential equation $\frac{\eta'''}{\eta}-\frac{3}{2}\left(\frac{\eta''}{\eta'}\right)^2=f(\eta)$, where $\eta'=\frac{d\eta}{dz}$ . . . ."

There are two papers by Lagrange, one immediately following the other, "Sur la construction des cartes géographiques," but I have not been able to discover the Schwarzian derivative in either of them.

[2] The form as it stands shows that for y a linear function of x and y may be substituted; and the form *reciprocated* (by the interchange of x and y) shows that a similar substitution may be made for x. Hence arbitrary linear substitutions may be simultaneously impressed as x and y without inducing any change of form.

jective or non-projective, are indicated by pure reciprocants, and are subject to the same Partial Differential Equation; just as, in the Theory of Binary Quantics, Invariants, although under one aspect they may be regarded as a self-contained special class, admit of being and are most advantageously studied in connection with, and as forming a part of, the whole family of forms commonly known by the name of "semi-, or subinvariants," but which I find it conduce to much greater clearness of expression and avoidance of ambiguity or periphrasis to designate as Binariants.

The question may here be asked, How, then, are projective and non-projective pure reciprocants to be discriminated by their external characters?

I believe that I know the answer to this question, which is, that the former are subject to satisfy a second partial differential equation of a certain simple and familiar type, but this is a matter upon which it is not necessary for me to enter on the present occasion.[1] It is enough for our present purpose to remark that every projective pure reciprocant must, so to say, be in essence a masked ternary covariant. For instance, if we take the simplest of all such, viz. a, i.e. $\frac{d^2y}{dx^2}$, we have

$$\frac{d^2y}{dx^2}\cdot\left(\frac{d\phi}{dy}\right)^3 = \begin{vmatrix} \frac{d^2\phi}{dx^2} & \frac{d^2\phi}{dxdy} & \frac{d\phi}{dx} \\ \frac{d^2\phi}{dxdy} & \frac{d^2\phi}{dy^2} & \frac{d\phi}{dy} \\ \frac{d\phi}{dx} & \frac{d\phi}{dy} & 0 \end{vmatrix}$$

which, for facility of reference, let me call M. Obviously we might instead of $a = 0$ substitute $M = 0$ to mark an inflexion. And now if we write Φ as the completed form of ϕ, when made homogeneous by the substitution of z for unity; and if we suppose it to be of n dimensions in x, y, z, and call its Hessian H, we shall obtain the syzygy

$$(n-1)^2\left(\frac{d\phi}{dy}\right)^3 \cdot a + H + \left\{\frac{d^2\Phi}{dx^2}\cdot\frac{d^2\Phi}{dy^2} - \left(\frac{d^2\Phi}{dxdy}\right)^2\right\}\Phi = 0.$$

Hence the system $\Phi = 0$, $a = 0$, will be in effect the same as the system $\Phi = 0$, $H = 0$, and in this sense a may be said to carry H as it were in its bosom. And so in general every pure projective reciprocant may, in the language of insect transformation, be regarded as passing, so to say, first from the grub to the pupa or chrysalis, and from this again, divested of all superfluous integuments, to the butterfly or imago state.

Non-projective pure reciprocants undergo only one such change. There is no possibility of their ever emerging into the imago—their development being finally arrested at the chrysalis stage.

It would, I think, be an interesting and instructive task to obtain the imago or Hessianised transformation of the Mongian, but I am not aware that any one has yet done, or thought of doing, this.[2] It seems to me that by substituting Reciprocants in lieu of Ternary Covariants we are as it were stealing a dimension from space, inasmuch as Reciprocants, *i.e.* Ternary Covariants in their undeveloped state, are closely allied to, and march *pari passu* with, the familiar forms which appertain to merely binary quantics.

I will now proceed to bring before your notice the general partial differential equation which supplies the necessary and sufficient condition to which all pure reciprocants are subject.

It is highly convenient to denote the successive derivatives

$$\frac{dy}{dx^2}, \frac{dy}{dx^3}, \frac{dy}{dx^4}, \ldots$$

by the simple letters $a, b, c, \ldots$

The first derivative $\frac{dy}{dx}$ plays so peculiar a part in this theory that it is necessary to denote it by a letter standing aloof from the rest, and I call it τ. This last letter, I need not say, does not make its appearance in any pure reciprocant. This being premised, I invite your attention to the equation in question, in which you will perceive the symbols of operation are separated from the object to be operated upon.

Writing $V = 3a^2\delta + 10ab\delta_c + (15ac + 10b^2)\delta_d + \ldots$ and calling any pure reciprocant R,

$$I'R = 0$$

is the equation referred to.

I cannot undertake, within the brief limits of time allotted to this lecture, to explain how this operation, or, as it may be termed, this annihilator V is arrived at. The table of binomial coefficients, or rather half-series of binomial coefficients, shown in Chart 4, will enable you to see what is the law of the numerical coefficients of its several terms. Let the words *weight, degree, extent* (extent, you will remember, means the number of places by which the most remote letter in the form is separated from the first letter in the alphabet) of a pure reciprocant signify the same things as they would do if the letters $a, b, c, \ldots$ referred, according to the ordinary notation, to Binariants instead of to Reciprocants. The number of binariants linearly independent of each other whose weight, extent, and order are w, i, j is given by the partition formula $(w; i, j) - (w-1; i, j)$ where in general $(w; i, j)$ means the number of ways of partitioning w into i or fewer parts none greater than j. It follows immediately from the mere form of V that the corresponding formula in the case of Reciprocants of a given type $w.i.j$ will be $(w; i, j) - (w-1; i+1, j)$ the augmentation of i in the second term of the formula being due to the fact that, whereas in the partial differential equation for Binariants it is the letters themselves which appear as coefficients, it is quadratic functions of these in the case of Reciprocants. From the form of V we may also deduce a rigorous demonstration of the existence of Reciprocants strictly analogous to those with which you are familiar in the Binarian Theory, which are pictured in Chart 2, and are now usually designated as Protomorphs, as being the forms by the interweaving of which with one another (or rather by a sort of combined process of mixture and precipitation), all others, even the irreducible ones, are capable of being produced. The corresponding forms for Reciprocants you will see exhibited in the same table. Each series of Protomorphs may of course be indefinitely extended as more and more letters are introduced. In the table I have not thought it necessary to go beyond the letter g. You also know that besides Protomorphs there are other irreducible forms, the organic radicals, so to say, into which every compound form may be resolved, always limited in number, whatever the number of letters or primal elements we may be dealing with. The same thing happens to Reciprocants as you will notice in the comparative table in Chart 2. Without going into particulars, I will ask you to take from me upon faith the assurance that there is no single feature in the old familiar theory, whether it relates to Protomorphs, to Groundforms, to Perpetuants, to Factorial constitution, to Generating Functions, or whatever else sets its stamp upon the one, which is not counterfeited by and reproduced in the parallel theory.

[1] In Paris, from which I correct the proofs, I have succeeded in reducing this conjecture to a certainty and in establishing the marvellous fact that every Projective Reciprocant, or, which is the same thing, every Differential Invariant, is, at the same time, an Ordinary Subinvariant. Thus a differential invariant (or projective reciprocant) may be regarded as *a single personality clothed with two distinct natures*—that of a reciprocant and that of a subinvariant.

[2] M. Halphen informs me that this has been done by Cayley in the *Phil Trans.* for 1865, and subsequently in a somewhat simplified form by Painvin, *Comptes rendus*, 1874. But neither of these authors seems to have had the Boole-Mongian objectively before them, so that a slight supplemental computation is wanting to establish the equation between it and the function which either of them finds to vanish at a *sextactic* point

So much—for time will not admit of more—concerning pure reciprocants.

Let me now say a few words *en passant* on Mixed Reciprocants.

Pure Reciprocants, we have seen, are the analogues of Invariants, or else of the leading terms [for that is what are Semi- or Subinvariants] of Covariantive expansions; each is subject to its own proper linear partial differential equation. Mixed Reciprocants are the exact analogues of the coëfficients in such expansions other than those of the leading terms. Starting from the leading terms as the unit point, the coefficients of rank ω are subject to a partial differential equation of order ω; and just so, mixed reciprocants, if involving τ up to the power ω, are subject to a partial differential equation of that same order.

I have alluded to a peculiar class of mixed under the name of "Orthogonal Reciprocants." They are distinguished, as I have proved, by the beautiful property that, if differentiated with respect to τ, the result must be itself a Reciprocant. In Chart 1 you will see this illustrated in the case of a mixed reciprocant $(1 + \tau^2)b - 3\tau a^2$, which serves to indicate the existence of points of maximum and minimum curvature. Its differential coefficient with respect to t is the oft-alluded-to Schwarzian, transliterated into the simpler notation. Proceeding in the inverse order—of Integration instead of Differentiation—I call your attention to a mixed reciprocant, of a very simple character, one which presents itself at the very outset of the theory, viz.—

$$\tau c - 5ab,$$

which, integrated in respect to t between proper limits, yields the elegant orthogonal reciprocant—

$$(\tau^2 + 1)c - 10ab\tau + 15a^3.$$

Expressed in the ordinary notation, this, equated to zero, takes the form—

$$\left\{\left(\frac{dy}{dx}\right)^2 + 1\right\}\frac{d^4y}{dx^4} - 10\frac{dy}{dx}\cdot\frac{d^2y}{dx^2}\cdot\frac{d^3y}{dx^3} + 15\left(\frac{d^2y}{dx^2}\right)^3 = 0.$$

Mr. Hammond has integrated this, treated as an ordinary differential equation, and has obtained the complete primitive expressed through the medium of two related Hyper-Elliptic Functions connecting the variables x and y (see Chart 3). It may possibly turn out to be the case that every mixed reciprocant is either itself an Orthogonal Reciprocant, or by integration, in respect to τ, leads to one.

It will of course be understood that, in interpreting equations obtained by equating to zero an Orthogonal Reciprocant, the variables must be regarded as representing not general but rectangular Cartesian co-ordinates.

Here seems to me to be the proper place for pointing out to what extent I have been anticipated by M. Halphen in the discovery of this new world of Algebraical Forms. When the subject first dawned upon my mind, about the end of October or the beginning of November last, I was not aware that it had been approached on any side by any one before me, and believed that I was digging into absolutely virgin soil. It was only when I received M. Halphen's letter, dated November 25, in relation to the Mongian business already referred to, accompanied by a presentation of his memoirs on Differential Invariants, that I became aware of there existing any link of connection between his work and my own. A Differential Invariant, in the sense in which the term is used by M. Halphen, is not what at first blush I supposed it to be, and as in my haste to repair what seemed to me an omission to be without loss of time supplied, I wrote to M. Hermite it was, in a letter which has been or is about to be inserted in the *Comptes rendus* of the Institute of France; it is not, I say, identical with what I have termed a general pure reciprocant, but only with that peculiar species of Pure Reciprocants to which I have in a preceding part of this lecture referred as corresponding and pointing to Projective Singularities. In his splendid labours in this field Halphen has had no occasion to construct or concern himself with that new universe of forms viewed as a whole, whether of Pure or Mixed Reciprocants, which it has been the avowed and principal object of this lecture to bring under your notice.

I anticipate deriving much valuable assistance in the vast explorations remaining to be made in my own subject from the new and luminous views of M. Halphen, and possibly he may derive some advantage in his turn from the larger outlook brought within the field of vision by my allied investigations.

Let me return for a moment to that simplest class of pure reciprocants which I have called protomorphs. Each of these will be found (as may be shown either by a direct process of elimination, or by integrating the equations obtained by equating them severally to zero, regarded as ordinary differential equations between x and y) each of these, I say, will be found to represent some simple kind of singularity at the point (x, y) of the curve to which these co-ordinates are supposed to refer. Thus, for instance, No. 1 marks a single point of inflexion; No. 2, points of closest contact with a common parabola; No. 3, what our Cayley has called sextactic points, referring to a general conic; No. 4, points of closest contact with a common cubical parabola; and so on. The first and third, it will be noticed, represent projective singularities, and as such, in M. Halphen's language, would take the name of Differential Invariants. The second and fourth, having reference to the line at infinity in the plane of the curve, are of a non-projective character, and as such would not appear in M. Halphen's system of Differential Invariants. It is an interesting fact that every simple parabola, meaning one whose equation can be brought under the form $y = x^{\frac{m}{n}}$, corresponds to a linear function of a square of the third, and the cube of the second protomorph, and consequently will in general be of the sixth degree. In the particular case of the cubical parabola, the numerical parameter of this equation is such that the highest powers of b cancel each other so that the form sinks one degree, and becomes represented by the *Quasi-Discriminant*, No. 4.

This simple instance will serve to illustrate the intimate connection which exists between the projective and non-projective reciprocants, and the advantage, not to say necessity, of regarding them as parts of one organic whole.

It would take me too far to do more than make the most cursory allusion to an extension of this theory similar to that which happens when in the ordinary theory of invariants we pass from the consideration of a single Quantic to that of two or more. There is no difficulty in finding the partial differential equation to double reciprocants which, as far as I have as yet pursued the investigation, appear to be functions of $a, b, c, \ldots$; $a', b', c', \ldots$; and of $(\tau - \tau')$.

The theory of double reciprocants will then include as a particular case the question of determining the singularities of paired points of two curves at which their tangents are parallel, and consequently the theory of common tangents to two curves and of bi-tangents to a single one.

I think I may venture to say that a general pure multiple reciprocant which marks off relative singularities, whether projective or non-projective, of a group of curves, is a function of the second and higher differential derivatives appertaining to the several curves of the group, and of the differences of the first derivatives, whereas in a mixed multiple reciprocant these last-named differences are replaced by the first derivatives themselves. As a particular case, when the group dwindles to an individual and there is only one τ, this letter disappears altogether from the form, for there are no differences of a single quantity.

In the chart (marked No. 2) you will see the table of Protomorphs carried on as far as the letter g inclusive, and will not fail to notice what may be termed the higher organisation of Reciprocantive as compared with ordinary Invariantive Protomorphs; the degrees of the latter oscillate or librate between the numbers 2 and 3, whereas in the former the degree is variable according to a certain transcendental law dependent on the solution of a problem in the Partition of Numbers. Another interesting difference between general Invariants and general Pure Reciprocants consists in the fact that, whilst the number of the former ultimately (*i.e.* when the extent is indefinitely increased) becomes indefinitely great, that of the latter is determinate for any given degree even for an infinite number of letters.

In carrying on the table of protomorphs up to the letter h (see Chart 6) a new phenomenon presents itself, to which, however, there is a perfect parallel in the allied theory. An arbitrary constant enters into the form, its general value being a linear function of U and W (for which see Chart 6). But this is not all. If you examine the terms in both U and W (there are in all twelve such) you will find that these twelve do not comprise all of the same type to which they belong. There is a Thirteenth (a banished Judas), equally *a priori* entitled to admission to the group, but which does not make its appearance among them, viz. b^4d. I rather believe that a similar phenomenon of one or more terms, whose presence might be expected, but which do not appear, presents itself in the allied invariantive theory, but cannot speak with certainty as to this point, as the circumstance has not received, and possibly does not merit, any very particular attention.

Still, in the case before us, this unexpected absence of a member of the family, whose appearance might have been looked for, made an impression on my mind, and even went to the extent of acting on my emotions. I began to think of it as a sort of lost Pleiad in an Algebraical Constellation, and in the end, brooding over the subject, my feelings found vent, or sought relief, in a rhymed effusion, a *jeu de sottise*, which, not without some apprehension of appearing singular or extravagant, I will venture to rehearse. It will at least serve as an interlude, and give some relief to the strain upon your attention before I proceed to make my final remarks on the general theory.

TO A MISSING MEMBER

Of a Family Group of Terms in an Algebraical Formula

Lone and discarded one! divorced by fate,
Far from thy wished-for fellows—whither art flown?
Where lingerest thou in thy bereaved estate,
Like some lost star, or buried meteor stone?
Thou mindst me much of that presumptuous one
Who loth, aught less than greatest, to be great,
From Heaven's immensity fell headlong down
To live forlorn, self-centred, desolate:
Or who, new Heraklid, hard exile bore,
Now buoyed by hope, now stretched on rack of fear,
Till throned Astræa, wafting to his ear
Words of dim portent through the Atlantic roar,
Bade him "the sanctuary of the Muse revere
And strew with flame the dust of Isis' shore."

Having now refreshed ourselves and bathed the tips of our fingers in the Pierian spring, let us turn back for a few brief moments to a light banquet of the reason, and entertain ourselves as a sort of after-course with some general reflections arising naturally out of the previous matter of my discourse. It seems to me that the discovery of reciprocants must awaken a feeling of surprise akin to that which was felt when the galvanic current astonished the world previously accustomed only to the phenomena of machine or frictional electricity. The new theory is a ganglionic one: it stands in immediate and central relation to almost every branch of pure mathematics—to Invariants, to Differential Equations, ordinary and partial, to Elliptic and Transcendental Functions, to Partitions of Numbers, to the Calculus of Variations, and above all to Geometry (alike of figures and of complexes), upon whose inmost recesses it throws a new and wholly unexpected light. The geometrical singularities which the present portion of the theory professes to discuss are in fact the distinguishing *features* of curves; their *technical* name, if applied to the human countenance, would lead us to call a man's eyes, ears, nose, lips, and chin his singularities; but these singularities make up the character and expression, and serve to distinguish one individual from another. And so it is with the so-called singularities of curves.

Comparing the system of ground-forms which it supplies with those of the allied theory, it seems to me clear that some common method, some yet undiscovered, deep-lying, Algebraical principle remains to be discovered, which shall in each case alike serve to demonstrate the finite number of these forms (these organic radicals) for any specified number of letters. The road to it, I believe, lies in the Algebraical Deduction of ground-forms from the Protomorphs.[1] Gordan's method of demonstration, so difficult and so complicated, requiring the devotion of a whole University semester to master, is inapplicable to reciprocants, which, as far as we can at present see, do not lend themselves to symbolic treatment.

How greatly must we feel indebted to our Cayley, who while he was, to say at least, the joint founder of the symbolic method, set the first, and out of England little if at all followed, example of using as an engine that mightiest instrument of research ever yet invented by the mind of man—a Partial Differential Equation, to define and generate invariantive forms.

With the growth of our knowledge, and higher views now taken of invariantive forms, the old nomenclature has not altogether kept pace, and is in one or two points in need of a reform not difficult to indicate. I think that we ought to give a general name—I propose that of Binariants—to every rational integral form which is nullified by the general operator

$$\lambda a d_b + \mu b d_c + \nu c d_d + \ldots .$$

where $\lambda, \mu, \nu, \ldots$ are arbitrary numbers.

This operator, I think, having regard to the way in which its segments link on to one another, may be called the Vermicular.

Binariants corresponding to unit values of $\lambda, \mu, \nu, \ldots$ may be termed standard binariants. Those for which these numbers are the terms of the natural arithmetical series 1, 2, 3, ... Invariantive binariants, which may be either complete or incomplete invariants; these latter are what are usually termed semi- or sub-invariants. I may presently have to speak of a third class of binariants for which the arbitrary multipliers are the numbers 3, 8, 15, 24 ... (the squares of the natural numbers each diminished by unity) which, if the theorem I have in view is supported by the event, will have to be termed Reciprocantive Binariants. But first let me call attention to what seems a breach of the asserted parallelism between the Invariantive and the Reciprocantive theories. In the former we have complete and incomplete invariants, but we have drawn no such distinction between one set of pure reciprocants and another. A parallel distinction does however exist.

If we use w, i, j to signify the weight, extent, and degree of an invariantive form, w is never less than the half product of ij; when equal to it the form is complete. In the case of reciprocants certain observed facts seem to indicate that there exists an analogous but less simple

[1] See the section on the Algebraical Deduction of the Ground-forms of the Quintic in my memoir on Subinvariants in the *American Journal of Mathematics*.

inequality. If this conjecture is verified it is not merely $\frac{ij}{2} - w$, but $\frac{ij}{2} - (j - 2) - w$, which is never negative: and when this is zero, the form may be said to be complete.[1] There would then be thus complete forms in each of the two theories; in the earlier one they take a special name: this is the only difference.

We have spoken of Pure Reciprocants as being either projective or non-projective, but so far have abstained from particularising the external characters by which the former may be distinguished from the latter. I have good reason to suspect that the former are distinguished from the latter by being Binariants; that, in addition to being subject to annihilation by the operator V, they are also subject to annihilation by the Vermicular operator when made special by the use of the numerical multipliers 3, 8, 15 . . . above alluded to, or in other words (as previously mentioned incidentally) are subject to satisfy two simultaneous partial differential equations instead of only one.[2] Projective Reciprocants we have seen are disguised or masked Ternary Covariants —Covariants in the grub, the first undeveloped state. Now ternary covariants are capable, it may or may not be generally known, of satisfying 6 reducible to 2 simultaneous Partial Differential Equations, and at first sight it might be surmised that nothing would be gained by the substitution of the two new for the two old simultaneous partial differential equations. But the fact is not so, for the old partial differential equations are perfectly unmanageable, or at least have never, as far as I know, been handled by any one, for they have to do with a *triangular heap*, whereas the new ones are solely concerned with a *linear series* of co-efficients.

I have alluded to there being a particular form common to the two theories. In the one theory it is the Mongian alluded to in the correspondence, which has been read, with M. Halphen. In the other it is the source of the skew covariant to the cubic. If the latter be subjected to a sort of MacMahonic numerical adjustment, it becomes absolutely identical with the former. Let us imagine that before the invention of Reciprocants an Algebraist happened to have had both forms present to his mind, and had thought of some contrivance for lowering the coefficients of the Mongian written out with the larger coefficients, and had thus stumbled upon this striking fact. It could not have failed to vehemently arouse his curiosity, and he would have set to work to discover, if possible, the cause of this coincidence. He would in all probability have addressed himself to the form which precedes the source alluded to in the natural order of genesis, and have applied a similar adjustment to the much simpler form, $ac - b^2$: having done so he would have tried to discover to what singularity it pointed—but his efforts to do so we know must have been fruitless, and he would have felt disposed to throw down his work in despair, for the intermediate ideas necessary to make out the parallelism would not have been present to his mind. So long as we confine ourselves to Differential Invariants, *i.e.* to projective pure reciprocants, we are like men walking on those elevated ridges, those more than Alpine summits, such as I am told[1] exist in Thibet, where it may be the labour of days for two men who can see and speak to each other to come together. Reciprocants supply the bridge to span the yawning ravine and to bring allied forms into direct proximity.

I have spoken of mixed reciprocants as being subject to satisfy not a linear partial differential equation, but one of a higher order dependent on the intensity, so to say, of its mixedness—the highest power, that is to say, of the first differential derivative which it contains, and it might therefore be supposed that these forms are much more difficult to be obtained than pure reciprocants. But the fact is just the reverse, for as I discovered in the very infancy of the inquiry, and have put on record in the September or October number of the *Mathematical Messenger*, mixed reciprocants may be evolved in unlimited profusion by the application of simple and explicit processes of multiplication and differentiation. From any reciprocant whatever, be it mixed or pure, new mixed ones may be educed infinitely infinite in number, inasmuch as at each stage of the process, arbitrary functions of the first differential derivative may be introduced.

The wonderful fertility of this method of generation excited warm interest on the part of one of the greatest of living mathematicians, the expression of which acted as a powerful incentive to me to continue the inquiry. They may be compared with the shower of December meteors shooting out in all directions and covering the heavens with their brilliant trains, all diverging from one or more fixed radiant-points, the radiant-point in the theory before us being the particular form selected to be operated upon.

The new doctrine which I have endeavoured thus imperfectly to adumbrate has taken its local rise in this University, where it has already attracted some votaries to its side, and will, I hope, eventually obtain the co-operation of many more. I have ventured with this view to announce it as the subject of a course of lectures during the ensuing term.

When I lately had the pleasure of attending the new Slade Professor's inaugural discourse, I heard him promise to make his pupils participators in his work by painting pictures in the presence of his class. I aspire to do more than this—not only to paint before the members of my class, but to induce them to take the palette and brush and contribute with their own hands to the work to be done upon the canvas. Such was the plan I followed at the Johns Hopkins University, during my connection with which I may have published scores of Mathematical articles and memoirs in the journals of America, England, France, and Germany, of which probably there was scarcely one which did not originate in the business of the class-room; in the composition of many or most of them I derived inestimable advantage from the suggestions or contributions of my auditors. It was frequently a chase, in which I started the fox, in which

[1] If this should turn out to be true, the "crude generating fraction" for reciprocants would be almost identical with that of in- and co-variants of the same extent j. The denominators would be absolutely identical; as regards the numerators, while that for invariantive forms is $1 - a^{-1}x^{-2}$ the numerator for reciprocants would be $1 - a^{-2}x^{-2j}$. As I write abroad and from memory there is just a chance that the index of a here given may be erroneous.

[2] As already stated in a previous footnote this conjecture is fully confirmed, my own proof having been corroborated (if it needed corroboration) by another entirely different one invented by M. Halphen, who fully shares my own astonishment at the fact of there being forms (half-horse, half alligator) at once reciprocants and sub-invariants, and as such satisfying two simultaneous partial differential equations.

If instead of denoting the successive differential derivatives (starting from the second $a, b, c, \ldots$ we call them $\frac{a}{1.2}, \frac{b}{1.2.3}, \frac{c}{1.2.3.4}, \ldots$ the two Annihilators will be

$$a\delta_b + 2b\delta_c + 3c\delta_d + 4d\delta_e + \ldots \text{ and}$$

$$4\frac{a^2}{2}\delta_b + 5ac\delta_c + 6(ad + bc)\delta_d + 7\left(ae + bd + \frac{c^2}{2}\right)\delta_e + \ldots$$

the latter being my new operator, the Reciprocator V, accommodated to the above-stated change of notation for the successive differential derivatives.

Hardly necessary is it for me to point out in explanation of the semi-sums $\frac{a^2}{2}, \frac{c^2}{2}, \ldots$ that we may write the MacMahonised V under the form

$$4a^2\delta_b + 5(ac + ca)\delta_c + 6(ac + bc)\delta_d + 7(ac + bd + c^2 + db + ea)\delta_e + \ldots$$

It is to be presumed that in addition to mixed reciprocants (the ocean into which flows the sea of pure reciprocants, as into that again empties itself the river of projective reciprocants) there may exist a theory of forms in which y as well as $\frac{dy}{dx}$ will appear, or, so to say, doubly mixed reciprocants, the most general of all, in which case we must speak of the content of these as the ocean and of the others as sea, river, and brook. Curious is it to reflect that in the theory which as it exists comprises Invariantives, Reciprocants, and Invariantive Reciprocants or Reciprocant Invariantives, the order of discovery was (1) Invariantives (Eisenstein, Boole, &c.); (2) Invariantive Reciprocants (Monge and Halphen); (3) Reciprocants (Schwarz, the author of this lecture).

[1] I think my informant was my friend Dr. Inglis, of the Athenæum Club, who some time ago undertook a journey in the Himalayas in the hopes of coming upon the traces of a lost religion which he thought he had reason to believe existed among mankind in the pre-Glacial period of the earth's history.

we all took a common interest, and in which it was a matter of eager emulation between my hearers and myself to try which could be first in at the death.

During the past period of my professorship here, imperfectly acquainted with the usages and needs of the University, I do not think that my labours have been directed so profitably as they might have been either as regards the prosecution of my own work or the good of my hearers: my attention has been distracted between theories waiting to be ushered into existence and providing for the daily bread of class-teaching. I hope that in future I may be able to bring these two objects into closer harmony and correlation, and think I shall best discharge my duty to the University by selecting for the material of my work in the class-room any subject on which my thoughts may, for the time being, happen to be concentrated, not too alien to, or remote from, that which I am appointed to teach; and thus, by example, give lessons in the difficult art of mathematical thinking and reasoning—how to follow out familiar suggestions of analogy till they broaden and deepen into a fertilising stream of thought—how to discover errors and to repair them, guided by faith in the existence and unity of that intellectual world which exists within us, and is at least as real as that with which we are environed.

The *American Mathematical Journal*, conducted under the auspices of the Johns Hopkins University, which has gained and retains a leading position among the most important of its class, whether measured by the value of its contents or the estimation in which it is held by the Mathematical world, bears as its motto—

πραγμάτων ἔλενχος οὐ βλεπομένων.

I have the pleasure of seeing among my audience this day the most distinguished geometer of Holland, Prof. Schoute, who has done me the signal honour of coming over to England to be present at this lecture, who hospitably entertained me at Groningen (in a vacation visit which I recently paid to his country, the classic soil which has given birth to an Erasmus, a Grotius, a Boerhaave, a Spinoza, a Huyghens, and a Rembrandt), and who was kind enough, in proposing my health at a party where many of his colleagues were present, to say that he felt sure "that I should return to England cheered and invigorated, and would, ere long, light on some discovery which would excite the wonder of the Mathematical world."

I do not venture to affirm, nor to think, that this vaticination has been fulfilled in the terms in which it was uttered, but can most truly say that the discovery, which it has been my good fortune to be made the medium of revealing, has excited my own deepest feelings of ever-increasing wonder rising almost to awe, such as must have come over the revellers who saw the handwriting start out more and more plainly on the wall, or the *scienziati* crowding round the blurred palimpsest as they began to be able to decipher characters and piece together the sentences of the long lost and supposed irrecoverable *De Republicâ.*

When I was at Utrecht, on my way to Groningen, Mr. Grinwis, the Professor of Mathematics at that University, showed me an English book on "Differential Equations," which had just appeared, of which he spoke in high terms of praise, and said it contained over 800 examples. I wrote at once for the book to England, and on seeing it on my arrival, forgetting that it had been ordered, mistook it for a present from the author or publisher, and, what is unusual with me, read regularly into it, until I came to the section on Hyper-geometrical series, where the Schwarzian Derivative (so named by Cayley after Prof. Schwarz) is spoken of.

Perhaps I ought to blush to own that it was new to me, and my attention was riveted by the property it possesses, in common with the more simple form which points to inflexions on curves, of remaining substantially unaltered, of persisting as a factor at least of its altered self, when the variables which enter it are interchanged. Following out this indication, I at once asked myself the question, "ought there not to exist combinations of derivatives of *all* orders possessing this property of reciprocation?" That question was soon answered, and the universe of mixed reciprocants stood revealed before me. These mixed reciprocants, by simple processes of combination, led me to the discovery of the first pure reciprocant, $3b^2 - 5ac$: whereupon I again put the question to myself, "are there, or are there not, others of this form, and if so, what are they?"

In an unexpected manner the question was answered, and my curiosity gratified to the utmost by the discovery of the partial differential equation which is the central point of the theory, and at once discloses the parallelism between it and the familiar doctrine of Invariants. Two principal exponents of that doctrine, who have infused new blood into it, and given it a fresh point of departure—Capt. MacMahon and Mr. Hammond—I have the pleasure of seeing before me. Mr. Kempe, who is also present, has lately entered into and signally distinguished himself in the same field, availing himself in so doing of his profound insight into the subject of linkages, his interest in which I believe I may say received its first impulse from the lecture which he heard me deliver upon it at the Royal Institution in January 1874, on the very night when the Prime Minister for the time being sent round letters to his supporters announcing his intention to dissolve Parliament. Of the two events I have ever regarded the lecture as by far the more important to the permanent interests of society. He has lately applied ideas founded upon linkages to produce a most original and remarkable scheme for explaining the nature of the whole pure body of Mathematical truth, under whatever different forms it may be clothed, in a memoir which has been recommended to be printed in the *Transactions* of the Royal Society, and which, I think, cannot fail when published to excite the deepest interest alike in the Mathematical and the Philosophical worlds.[1]

I also feel greatly honoured by the presence of Prof. Greenhill, who will be known to many in this room from his remarkable contributions to the theory of Hydrodynamics and Vortex Motion, and who has sufficient candour and largeness of mind to be able to appreciate researches of a different character from those in which he has himself gained distinction.

I should not do justice to my feelings if I did not acknowledge my deep obligations to Mr. Hammond for the assistance which he has rendered me, not only in preparing this lecture which you have listened to with such exemplary patience, but in developing the theory; I am indebted to him for many valuable suggestions tending to enlarge its bounds, and believe have been saved, by my conversations with him, from falling into some serious errors of omission or oversight. Saving only our Cayley (who, though younger than myself, is my spiritual progenitor—who first opened my eyes and purged them of dross so that they could see and accept the higher mysteries of our common Mathematical faith), there is no one I can think of with whom I ever have conversed, from my intercourse with whom I have derived more benefit. It would be an immense gain to Science, and to the best interests of the University, if something could be done to bring such men as Mr. Hammond (and, let me add, Mr. Buckheim, who ought never to have been allowed to leave it) to come and live among us. I am sure that with their endeavours added to my own and those of that most able body of teachers and researchers with whom I have the good fortune to be associated—my brother Professors and the Tutorial Staff of the University—we

[1] In his memoir for the *Phil. Trans.* Mr. Kempe contends that any what ever mathematical proposition or research is capable of being represented by some sort of simple or compound linkage. One would like to know by what sort of linkage he would represent the substance of the memoir itself.

could create such a School of Mathematics as might go some way at least to revive the old scientific renown of Oxford, and to light such a candle in England as, with God's grace, should never be put out.[1]

TABLES OF SINGULARITIES AND FORMULÆ REFERRED TO IN THE PRECEDING LECTURE

CHART I.

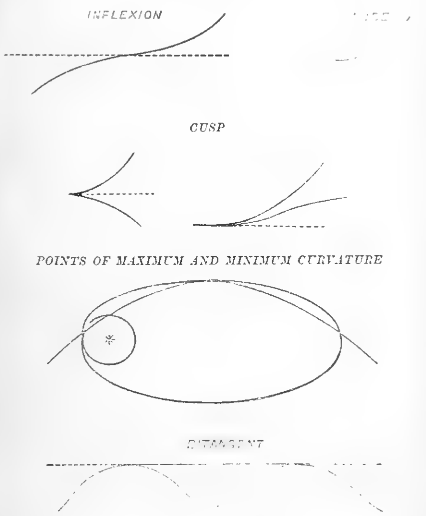


CHART 2.—PROTOMORPHS

Binariants	*Reciprocants*
a	a
$ac - b^2$	$3ac - 5b^2$
$a^2d - 3abc + 2b^3$	$9a^2d - 45abc + 40b^3$
$ae - 4bd + 3c^2$	$5a^2e - 35abd + 7ac^2 + 35b^2c$
$a^2f + 5abe + 2acd + 8b^2d - 6bc^2$	$45a^3f - 420a^2be - 42a^2cd + 1120ab^2d - 315abc^2 - 1120b^3c$
$ag - 6bf + 15ce - 10d^2$	$a^2g - 12abf - 450ace + 792b^2e + 588ade^2 - 2772bcd + 1925c^3$

CHART 3.

No. 1. a
No. 2. $3ae - 5b^2$
No. 3. $9a^2d - 45abc + 40b^3$
No. 4. $45a^3d^2 - 450a^2bc + 192a^2c^3 + 400ab^3d + 165ab^2c^2 - 400b^4c$

$$x = \int \frac{dt}{\sqrt{\kappa(1 - 15t^2 + 15t^4 - t^6) + \lambda(3t - 10t^3 + 3t^5)}} + \mu$$

$$y = \int \frac{tdt}{\sqrt{\kappa(1 - 15t^2 + 15t^4 - t^6) + \lambda(3t - 10t^3 + 3t^5)}} + \nu$$

$$V = 3a^2\delta_b + 10ab\delta_c + (15ac + 10b^2)\delta_d + (21ad + 35bc)\delta_e + (28ae + 56bd + 35c^2)\delta_f + \ldots$$

CHART 4.—COEFFICIENTS OF ANNIHILATOR V

1	4	3			
1	5	10			
1	6	15	10		
1	7	21	35		
1	8	28	56	35	
1	9	36	84	126	
1	10	45	120	210	126

CHART 5.—RECIPROCANT TRANSFORMATIONS

Grub — *Chrysalis* — *Imago*

$$\frac{d^2y}{dx^2} \qquad \begin{vmatrix} \frac{d^2\phi}{dx^2} & \frac{d^2\phi}{dxdy} & \frac{d\phi}{dx} \\ \frac{d^2\phi}{dxdy} & \frac{d^2\phi}{dy^2} & \frac{d\phi}{dy} \\ \frac{d\phi}{dx} & \frac{d\phi}{dy} & \bullet \end{vmatrix} \qquad \begin{vmatrix} \frac{d^2\Phi}{dx^2} & \frac{d^2\Phi}{dxdy} & \frac{d^2\Phi}{dxdz} \\ \frac{d^2\Phi}{dxdy} & \frac{d^2\Phi}{dy^2} & \frac{d^2\Phi}{dydz} \\ \frac{d^2\Phi}{dxdz} & \frac{d^2\Phi}{dydz} & \frac{d^2\Phi}{dz^2} \end{vmatrix}$$

(*a*) (*M*) (*H*)

$$(n-1)^2\left(\frac{d\phi}{dy}\right)^3 a + H + \left\{\frac{d^2\Phi}{dx^2}\cdot\frac{d^2\Phi}{dy^2} - \left(\frac{d^2\Phi}{dxdy}\right)^2\right\}\Phi = 0.$$

$\dfrac{dy}{dx}\dfrac{d^3y}{dx^3} - \dfrac{3}{2}\left(\dfrac{d^2y}{dx^2}\right)^2$ is the Schwarzian, otherwise written $tb - \dfrac{3a^2}{2}$.

CHART 6.—THE H RECIPROCANTIVE PROTOMORPH

U	W
$65a^4h$	$120a^3cf$
$-975a^3bg$	$-200a^2b^2f$
$-990a^3cf$	$-195a^2de$
$+6200a^2b^2f$	$-145a^2bce$
$+4690a^2bce$	$+1000ab^3e$
$-1540ab^3e$	$+1365a^2bd^2$
$-2730a^2bd^2$	$-777a^2c^2d$
$+7161a^2c^2d$	$-22260ab^2cd$
$+3080ab^2cd$	$+2485abc^3$
$-24255abc^3$	$+105b^3c^2$
$+25410b^3c^2$	

$$H + \Lambda U + MW$$

Λ and M are arbitrary numbers.

The Vermicular Operator

$$\lambda a\delta_b + \mu b\delta_c + \nu c\delta_d + \pi d\delta_e + \ldots$$

Examples

$$a\delta_b + b\delta_c + c\delta_d + d\delta_e + \ldots$$
$$a\delta_b + 2b\delta_c + 3c\delta_d + 4d\delta_e + \ldots$$
$$3a\delta_b + 8b\delta_c + 15c\delta_d + 24d\delta_e + \ldots$$

☞ b^4d does not appear in either U or W.

New College, Oxford, January 6

[1] I have purposely confined myself in my lecture to reciprocants, indicatives of properties of plane curves, but had in view to extend the theory to the case of higher dimensions in space leading to reciprocants involving the differential derivatives of any number of variables $y, z, \ldots$ M. Halphen, with whom I have had the great advantage of being in communication during my stay in Paris, has anticipated me in this part of my plan, and has found that the same method which I have used to obtain the Annihilator V applied to a system of variables leads to an Annihilator of very similar form to V, and at my request will publish his results in a forthcoming number of the *Comptes rendus*. Thus the dominion of reciprocants is already extended over the whole range of forms unlimited in their own number as well as in that of the variables which they contain

THE GEOLOGY OF MALAYSIA, SOUTHERN CHINA, &c.

THERE is a remarkable uniformity in the geology of a very large portion of Southern Asia and its dependent islands, especially from the Malay peninsula, as far east as the Philippines, and as far north as the Chinese continent. In the Malayan peninsula we have an elevated granitic axis. At the base of this there are Palæozoic schists and slates. Above these in a few places there are limestones in detached weathered masses. This limestone is often crystalline, white, blue, and black. In a few cases there are traces of stratification, but no fossils.

In a recent journey through Pahang I found precisely the same formations on the eastern side of the peninsula, with only this addition, that there is a belt of trachytic rocks of modern origin forming detached hills between the main range and the sea.

In Sumatra I learn that there are the same formations from the granite upwards. I cannot confirm this from personal observation, as I have travelled very little in the island. The mountain axis is far from the Straits of Malacca, and difficult of access. As far as I can judge from the geology of such large islands as Bilitou, Bintang, and Banca, the mountains are probably granitic and stanniferous.

Proceeding eastward and northerly, detached granite islands are met with. They are thickly strewn through the intermediate ocean. Those I have seen, such as the north and south Natunas, and other similar outliers, on voyages between Java, Singapore, Borneo, China, Cochin

China, and Siam, are all granitic, with a few Palæozoic slates and schists. To the eastward of the Malay peninsula a few limestone islands are seen, and they are similar in character to the calcareous rocks of the mainland.

It is perhaps needless to draw attention to the extraordinary number of these outliers. They do not show well on a map, as most of them are so very small, but those who travel in these regions can well understand why the early Arabian voyagers called this "the sea of the twelve thousand islands." Granite is the prevailing rock, but I have little doubt that modern trap-rocks form some of the islands. But there is no active volcano amongst them. The nearest point for such phenomena is said to be Formosa, but I think this doubtful. Yet, proceeding north from this large island, along the chain which connects it in an almost unbroken series through the Meiaco group, Liu Kiu and Linschoten Islands, to Japan, we find two active volcanoes (Naka Sima and Sawa Sima, the latter 3400 feet high), which seem to point to a line of disturbance, of which Formosa is a portion.

When we come to Borneo we find the first extensive development of stratified rocks. Though outliers of granite are met occasionally, it is evident that there is a great change in the geology of the coast. I shall confine my observations to what I saw. From Brunei northwards we meet with carbonaceous rocks, brown and yellow sandstones and shales with intercalated grits and conglomerates. The dip varies: sometimes slight, or nearly horizontal, showing but trifling disturbance in this part of the world. It seemed to me as if these carbonaceous rocks were of different ages. Those which line the Brunei River are much older-looking than those of Labuan. At Gaya, and again at Kudat, at the north extremity of Borneo, I saw brownish-yellow sandstones with shales and small seams of coal. The appearance of these beds reminded me much of the Mesozoic carbonaceous rocks of Queensland and New South Wales. At Sandakan or Elopura (North-East Borneo) the present capital of the North Borneo Settlement, there are high cliffs of red and yellow sandstone, which look older than anything I saw on the north or north-eastern coast. Over 600 feet are exposed in one cliff, with no signs of any carboniferous strata.

While at Sandakan I met the Governor's private secretary (Mr. D. D. Daly), who had just returned from a journey of exploration on the Kinebetungen River. He brought down many samples of good coal, besides tin and gold. Amongst the collection were some limestones very like the rocks I had seen in the Malay peninsula. These also form detached mountains. There are fine caves, I am informed, over 600 feet high, and in them are found some of the best kinds of edible birds' nests. Amid the fragments of limestone I recognised a Fenestella and a Stenopora. If this rock is of the same formation as the limestone outliers of the whole of Malaysia, then its age may be for the present considered as Palæozoic, and probably between Devonian and Carboniferous.

After visiting some islands of the Sooloo Archipelago (all volcanic) I went to the Philippines. At Luzon, Mindoro, and some of the larger members of the group, the rocks are principally volcanic. But it would be an error to regard them as exclusively so. There are some areas of stratified rocks with coral and other marine fossils, which are of probably Miocene and Pliocene age. In Mindanao there is gold. I obtained a few fossils from the Miocene beds of the latter island. They were all Foraminifera in a loose friable limestone, including *Orbulina universa*, D'Orb., *Globigerina biloba*, *triloba*, and *bulloides*, D'Orb., *Cristellaria italica*, D'Orb., *Pulvinulina Haueri*, D'Orb., *Rotlaia simplex*, D'Orb., and some others belonging to about twenty different genera. The same species are found in Luzon, and the beds are considered Eocene by Kusrer (see *Boletin de la Carta Geol. del. España*, vol. vii).

One of the most interesting portions of the Philippines is the Calamianes group, a small cluster of islands a short distance south and west of Mindoro. Here we find repeated the main geological features of the Malayan peninsula, with the addition of recent volcanic emanations. To the east of Busuanga (the largest of the group) is the Island of Coron, which presents to the sea a magnificent rampart of limestone cliffs and pinnacles from 600 to 1500 feet high. The aspect is grandly picturesque, but the character of the formation is unmistakably similar to the isolated limestone mountains in the Malayan Peninsula. The rocks are bluish-gray, with apparently a perpendicular stratification, with patches of brilliant colours, including red, yellow, pink, dark and light green, &c. The cliffs descend precipitously into about forty fathoms of water, but at the tidal line they are undermined by the action of the waves in a very cleanly-cut line. Occasionally one may see the natives (Visayas) lowering each other over these dizzy heights to gather the edible birds' nests which here also abound, and form the only valuable export from the islands. The outline of the island is magnificently rugged and irregular, weathered into needles and pinnacles of the most fantastic shape, in the recesses of which there is much pale green grass and patches of darker jungle. Caves are of course numerous. It was the birds'-nesting harvest at the time of my visit in March last.

The Island of Malagou, to the westward is similar to Culion, but it possesses the additional feature of a second line excavated by the waves about ten feet above the actual level. This seems to be the result of upheaval. Besides Malagou there are many small limestone islets, or mere pinnacles of grotesque shape. The seas are thus rendered peculiarly dangerous. The only port worthy of the name is Port Culion, with a town which is a mere cluster of Malay huts of bamboo and palm-leaves. The rocks are Palæozoic schists and quartzites. Thus we have a repetition of the formations as they occur in the Malayan Peninsula.

At Palawan and Mindanao the same formations are stated to occur. Of Mindanao there can be no doubt, but of Palawan little is known, and I have only seen the coast at a distance.

There is a continuance of the same geological features in South China, at least from those portions of the coast which I have seen between Macao and Swatow. At Hong Kong we have granite, ancient trap-rocks, felsites, and detached outliers of limestone exactly like the Palæozoic deposits all through the Eastern Archipelago. From the Canton River the same rocks have been seen by me together with well-marked Palæozoic fossils of carboniferous type (*Spirifer* especially).

I have never succeeded in getting away from the alluvial deposits of the great rivers of Cochin China. Just now the time could not be more unfavourable for any kind of exploration, but I believe the French are not neglecting the geology of the country.

Coal is extensively distributed in all the northern portions of the countries I have been describing. It is found in South China abundantly, Formosa, Tonquin, the Philippines, Japan, and Borneo, and I believe I have seen indications of a carbonaceous deposit in the Malay Peninsula.

Of the coals in South China little more is known than that they are abundant and of good quality. From the fossils I have seen they are probably of Palæozoic age. The Formosa coals are so bad that they have ceased to be worked or at least offered in the Hong Kong market. I know nothing of their age nor of the quality and age of the coals of Tonquin. The coals of the Philippines belong most probably to the Borneo older series. They are found on the south of Luzon and south of Zebu since 1827. More recently they have been found in the province of Albay (south-east of Manilla) and in Panay.

Samples from the latter mines were tried by the P. and O. Company with good results. The Japan coals are certainly Tertiary and most probably Miocene. Though brittle, they make such good steam coals that they are preferred to every other except Cardiff coal. Borneo is a mass of coal, and, as I believe, of very different ages. Those of Labuan were said to be Tertiary; those of Brunei look much older. But I question the Tertiary age of the Labuan beds.

The general character of the geology of the regions I have mentioned is (1) Granite rocks with older volcanic dykes; (2) Palæozoic schists and slates; (3) Limestones in detached outliers, probably of Carboniferous age; (4) Coal of various ages. There has been little upheaval, and that has revealed marine, Miocene, and Pliocene beds, with some few carbonaceous deposits.

J. E. TENISON-WOODS

Osaka, Japan, September 24, 1885

JOHN HUNTER'S HOUSE

EARL'S COURT HOUSE, once the residence of the illustrious John Hunter, has been made very properly the subject of a letter in the *Times* of Tuesday last, by Dr. Farquharson, M.P. The house, with which I have been familiar for the past twenty-two years, is well worth all the attention of the curious which Dr. Farquharson claims for it. It differs, no doubt, somewhat from what it was in Hunter's time, but not so much, I think, as my friend supposes; for a drawing I have had made of it, when compared with another drawing taken not long after Hunter's death, and now in the possession of the Royal College of Surgeons, shows no very important change. The Lions' Den, of which I have also had a faithful copy taken, is still in good preservation, and Mrs. Hunter's boudoir retains all its original character, as she, the accomplished authoress of the well-known song,—

"My mother bids me bind my hair,"—

had it herself decorated. The copper in which the Irish giant was boiled down is in good order, and stands in an outhouse in the same place in which it stood when the giant, in piecemeal, found his way into it. In 1850 the late distinguished scholar, Dr. Robert Willis, of Barnes, took me to Kensington to see a man who remembered John Hunter. He was the son of Hunter's gardener, and was ten years of age at the time of Hunter's death in 1793. This man related some curious anecdotes of the great anatomist. One of these had reference to his presence of mind. One day as Hunter was entering his garden by the field at the back, still a field, one of the lions had got loose from its den. From the house the people called out to Hunter to get out of the way into a place of safety. Instead of this he took his handkerchief from his pocket, and marching boldly up to the lion, flipped it back into the den, and securely shut it in.

That Hunter conducted dissections in this place is clear from the remains that have been dug up in the garden. I examined a number of bones that were thus unearthed by the late occupier during some improvements which were going on about fifteen years ago. The bones showed some sections and re-sections of so curious and skilful a kind, that I asked and obtained permission to retain a few of them.

Upon the death of John Hunter, Earl's Court, held for a time by Mrs. Hunter, and by more than one future occupier, was turned into an asylum for ladies under restraint for lunacy, was held for many years as that by the Misses Bonney, and got the general name of "Miss Bonney's House" or Asylum. In 1864 it passed, still as an asylum, into the possession of my late friend Dr. Gardner Hill, who played so great a part as the practical pioneer of the system of the treatment of the insane without restraint. Dr. Hill continued to reside in the house till his death, by apoplexy, a few years ago, and his family have held it since his death up to the close of the past year, when they left it on the expiration of their lease. The fate of the house will almost certainly be its absorption, with its grounds, into a square or a series of streets, so that nothing will remain of it beyond the views which I and others who are given to antiquarian research may have taken of it, and at my instance Mr. Gardner has added several views to his magnificent collection of London. The memory of the place is thus secured for the future at least. But I agree with my learned brother Farquharson that the copper ought to go to the Hunterian Museum, to join the giant who is already so conspicuous and famous there.

BENJAMIN WARD RICHARDSON

NOTES

AN American Pasteur Institute has been incorporated in New York, its declared objects being the study and treatment of rabies and diseases susceptible of inoculation.

THE Rev. Thomas John Main, formerly Fellow of St. John's College, Cambridge, and a chaplain in the Royal Navy, died on the 28th ult. Mr. Main took his Bachelor's degree at St. John's College in 1838, as Senior Wrangler and first Smith's Prizeman, and proceeded M.A. in due course. He was for a period of thirty-four years Professor of Mathematics at the Royal Naval College at Portsmouth. Mr. Main was the author of various works on the marine steam-engine.

THE death is announced from St. Petersburg of Prof. Zakharow, of the University there, an eminent Orientalist. Nearly thirty years ago he went to China as a Russian missionary, and after General Ignatieff's Treaty of Pekin in 1860, he was employed, on account of his knowledge of Chinese and Manchu, in the work of delimiting the frontier created by that treaty. He then prepared a large map of this region, of which only one copy has been made, which is at present in the Russian Topographical Department. He also compiled a Manchu-Russian dictionary, published in 1875, and a Chinese-Manchu-Russian dictionary was almost completed at the time of his death. On his return to Europe he was appointed Professor of Manchu in the University of St. Petersburg, and in addition to his dictionaries compiled also a grammar of that language, which is now dying out in China, as the Manchus are a mere handful in the midst of the Chinese Empire, and are gradually losing their special tongue. Manchu is, however, still used at Chinese Court ceremonials, and in officially addressing the Emperor of China in person. M. Zakharow's great works have therefore a special value.

THE Association for the Improvement of Geometrical Teaching will hold its annual general meeting on Friday, January 15, at 11.30 a.m., at University College, Gower Street. At the afternoon meeting (2 p.m.) the President (R. B. Hayward, F.R.S.) will give an address on the Correlation of the Different Branches of Elementary Mathematics. A discussion will follow the reading of the address. Persons interested in the objects of the Association or in the subject of the address are cordially invited to attend.

THE Prince of Wales having expressed his desire that specimens of Australian fish might be exhibited in the Aquarium which will be opened in connection with the forthcoming Indian and Colonial Exhibition, the Trustees of the Melbourne Exhibition Building have given the matter their consideration, with a view of determining if specimens of therarer varieties could be sent from the Melbourne Aquarium. It has, however, been found that very great cost would be incurred in sending anything like an adequate supply of fish, and the project has therefore been abandoned. It has been decided instead to forward for exhibition in the Victorian Court upwards of 100 water-colour drawings of the fishes of the colony, which have been executed to the order of the Trustees by a competent artist, and which, it is hoped, will be of interest to ichthyologists and others. It is also the intention of the Trustees to request the Government to assist them in the production of a descriptive work on Victorian fishes, the illustrations of which will be taken from these drawings. Prof. M'Coy has promised his assistance, and Mr. J. E. Sharrard, the Secretary to the Trustees, is already engaged in collecting materials for the work.

It is announced that the seventh Congress of Orientalists will be held at Vienna in September next. The sittings will take place in the lecture-hall of the new University. It is hoped that the Archduke Rénier will act as honorary president.

Among the additional lectures announced at the Society of Arts are:—"The Experiments with Lighthouse Illuminants at the South Foreland," by E. Price Edwards; "Magnetism of Ships and the Mariner's Compass," by Mr. W. Bottomley, jun.; "Photography and the Spectroscope in their Application to Chemical Analysis," by Prof. W. N. Hartley; "The Scientific Development of the Coal-Tar Industry," by Prof. R. Meldola.

Reports reached London on Tuesday that a severe shock of earthquake was felt on Monday morning at 10.20, all along the route between Dartmouth and Kingsbridge, Devonshire, as well as at other places lying more inland. Just after leaving Dartmouth the driver of an omnibus which runs daily to and from Kingsbridge experienced an oscillation of the ground, which lasted some seconds. On arriving at Stoke Fleming a number of persons stated that they felt the shock. A house at Stokepenny is stated to have "rocked." In the "Green Dragon" public-house the shock caused a quantity of plaster to fall down from the ceilings. At Street the oscillation was similarly felt. At Blackawton the shock is reported to have been very conspicuously felt. It appears, however, to have been most severe at Torcross. The occupants of the "Fisherman's Arms" public-house, which stands on the beach, were so frightened that they rushed out of the place, thinking, as they said, that the building was going to fall. Mr. T. R. Vickary, of the Torcross Hotel, gives several particulars of the severity of the shock. It appears to have been felt by almost every one in the village. At Stoneham, Chillington, and Frogmore the oscillation was also experienced.

A slight shock of earthquake, lasting seven seconds, was felt in Venice at 11 o'clock on the night of the 29th ult. No damage was done.

The volcano of Colima, on the Pacific coast of Mexico, exhibited a violent eruption on the 27th ult., which caused great alarm. The streams of lava completely covered the sides of the mountain. At the date of the last report flames were still darting from the crater, and clouds of smoke overhung the summit.

Mr. Blanford's theory of the winter rains of Northern India, based on a study of the meteorological registers, is as follows:—We have, he says, in the first instance, steady evaporation over an extensive moderately humid tract, at a comparatively low temperature, it is true, but in an atmosphere the stillness of which allows of the steady diffusion of the vapour to high levels, and the consequent formation of cloud. The slight disturbance of the baric equilibrium which follows (since the vertical decrease of temperature in a cloud-laden atmosphere is slower than in a clear atmosphere) is succeeded by a gentle indraught of warmer and more humid air from the south; for the Himalaya bars access to northerly winds. A vortex is then rapidly formed, accompanied with an increased cloud-formation, and speedily followed by precipitation, which takes the form of snow on the hills, and of rain over the river plains. The rainfall is invariably followed by a cool wind, and a wave of high barometric pressure from the west, which Mr. Blanford attributes to a drainage of cool heavy air from the valleys of the hills surrounding the Punjaub and the high lands of Beloochistan and Afghanistan—air cooled by precipitation on the mountains. If this theory be correct, the stillness of the atmosphere, combined with the presence of a moderate evaporation, must be accepted as the condition which primarily determines the formation of barometric minima and the winter rains of Northern India. As this stillness is due to the presence of lofty mountain-ranges in the north, it follows that, if the Himalayan chain were absent, these rains would probably cease, for any local evaporation in the Punjaub and the valley of the Ganges would be swept away by strong dry north-east winds blowing from the seat of high pressure, which in the winter months lies in Central Asia.

The electric lighting of the French Opera House is almost complete. The number of incandescent lights is 3000.

M. Joubert, the director of the Trocadéro popular Observatory, has made arrangements with the several telegraphic stations in Paris, so that the public may be warned when the sky is deemed sufficiently clear for conducting observations and demonstrations.

Messrs. Swan Sonnenschein and Co. announce for early publication a Pocket Handbook to the Flora of the Alps, specially adapted for botanical tourists, and edited by Mr. A. W. Bennett.

According to the Report for the past year of the Superintendent of the Royal Botanic Garden at Calcutta, further attempts to introduce into Bengal the kind of plantain (*Musa textilis*) from which Manilla hemp is derived have proved failures, owing to the low temperature of the cold weather; but the plant (*Sanseviera Zeylanica*) from which bow-string hemp is obtained grows very well. The Japan paper-mulberry, which has lately been introduced, has also been a success. Efforts are being made to introduce other plants of economic value, the principal being the coca plant, from which the important alkaloid cocaine is derived. The additions to the herbarium during the year appear to have been unusually large and comprehensive. As an example of the public utility of the Garden, it may be mentioned that 23,433 living plants were distributed to public institutions in India, while those sent abroad were proportionally numerous. In the same way 2,979 packets of seeds were sent out. The Report of the Lloyd Botanic Garden in Darjeeling is also included in the paper, which concludes with the usual statistical returns. We are glad to notice at the end a copy of a resolution conveying the thanks of the Lieutenant-Governor of Bengal to those concerned in administering the Gardens.

We have received the numbers of the *Journal* of the Asiatic Society of Bengal (Science Section) for 1885, so far as they have been published. They contain in all eleven papers, some being continuations of papers previously published. Mr. Lionel de Nicéville contributes a fourth list of butterflies taken at Sikkim in October 1884, with notes. The number of species already recorded was 284, which is now raised to 313, or about twice the number of species found throughout the year in Calcutta; but even this number does not exhaust the region, for some valleys and the higher elevations were not explored. The same writer describes some new Indian *Rhopalocera*, and also a list of the butterflies of Calcutta and its neighbourhood, with notes on their habits, food-plants, &c. Mr. Atkinson publishes the second and third instalment of his notes on Indian

Rhynchota. Dr. Giles, the Surgeon-Naturalist to the Indian Marine Survey, writes on the structure and habits of *Cyrtophium calamicola*, a new tubicolous amphipod from the Bay of Bengal, a description of a new species of the amphipod genus *Melita* from the same place, and notes on Prothallus of *Padina pavonia.* These three form part of the Natural History Notes of the Indian Marine Survey steamer *Investigator.* Commander Alfred Carpenter, of the same steamer, under the title "The Swatch of no Ground," explains the presence in the deltaic banks ("the-Swatch") off the mouths of the Ganges and the Brahmaputra of channels of great depth. Mr. Hill, the Meteorological Reporter to the North-Western Provinces and Oudh, contributes observations on the solar thermometer at Lucknow, while last of all comes a paper from Japan. Dr. O. F. von Möllendorff (not to be confounded with his brother of recent Corean fame) writes on Japanese land- and freshwater-mollusks, a series of notes based chiefly on a collection made by Dr. John Anderson during the year 1884, and sent to the writer for classification.

WE are glad to learn that Prof. Morse, Director of the Peabody Academy of Science, has in the press a work entitled "Japanese Homes and their Surroundings." Prof. Morse, it may be remembered, was Professor of Zoology in the University of Tokio, and his prehistoric discoveries in Japan formed one of the earliest of the publications of that institution. The publishers of the work, which will contain numerous illustrations by the author, are Messrs. Ticknor and Co. of Boston.

AT a meeting of the Seismological Society of Tokio held on November 18, 1885, in the University there, Prof. Shida described an instrument which he had designed to give an automatic record of earth-currents. The chief feature in it is an ingenious method of obtaining a record of the position of the coil or needle which indicated the current which might be passing through the instrument. This was accomplished by the needle, as it turned, making a series of almost frictionless electrical contacts between a series of metallic points and a film of liquid. The instrument has been practically worked, and is said to have yielded satisfactory records. A second paper by the same writer gave a history of all the facts with which we are acquainted respecting the phenomena of earth-currents. A considerable portion of the material embodied in the paper was derived from Prof. Shida's own observations on the lines and cables of this country. He made numerous references to instances where earth-currents of unusual magnitude had accompanied or preceded earthquakes. Many theories have been advanced to account for these phenomena, and it has been demonstrated by several investigations that they have a connection with the occurrence of sunspots. In the discussion which followed, Prof. Knott referred to the possibility of these disturbances being due to the inductive action of electrified bodies of air, while Prof. Milne added to the instances adduced by Prof. Shida of the simultaneous occurrence of earthquakes and earth-currents. Earthquakes occurring in America have, by the currents which had accompanied them, recorded themselves in Europe.

THE Japanese do not appear to have lost any of their faith in the efficacy of vaccination for the small-pox. They have just enacted a very stringent law on the subject, for, besides ordinary vaccination in the first year of infancy, it provides for at least two subsequent re-vaccinations at intervals of from five to seven years, so that by the time a child has reached its fifteenth year it will have been vaccinated three times. Besides, during epidemics of small-pox, local authorities have power, when they deem it necessary, to order the vaccination of all the inhabitants of their districts, irrespective of the vaccinations required by the law.

WE are informed that it is not the case that Dr. Sklarek has arranged to edit a new scientific journal to be published in Brunswick.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. T. W. Hall; a Sooty Mangabey (*Cercocebus fuliginosus* ♀) from West Africa, presented by Mr. T. Riseby Griffith; a Common Badger (*Meles taxus*), British, presented by Mr. Charles E. Russell; a Siamese Blue Pie (*Urocissa magnirostris*) from Siam, a Chinese Jay Thrush (*Garrulus chinensis*) from China, a Brazilian Hangnest (*Icterus jamaicai*) from Brazil, presented by Mr. Charles Clifton, F.Z.S.; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Mr. C. Kerry Nicholls, F.Z.S.; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Miss Shackthwaite; a Larger Hill-Mynah (*Gracula intermedia*) from India, presented by Miss G. Lampard; a Greater Spotted Woodpecker (*Dendrocopus major*), British, presented by Mr. A. S. Hutchinson; a Scops Owl (*Scops giu*), British, presented by Mr. J. H. Leech, F.Z.S.; a Caracal (*Felis caracal*), a Puff Adder (*Vipera arietans*), three Horned Vipers (*Vipera cornuta*), an African Cobra (*Naia haje*), a Hyghian Snake (*Elaps hygiæ*), a Smooth-bellied Snake (*Homolosoma lutrix*), two Rhomb-marked Snakes (*Psammophylax rhombeatus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; twelve Quails (*Coturnix communis*) from South Africa, presented by Capt. M. P. Webster; a Leopard (*Felis pardus*) from India, five Mauge's Dasyures (*Dasyurus maugæi*), a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, deposited; a Virginian Opossum (*Didelphys virginiana*) from North America, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

DISCOVERY OF A NEW NEBULA BY PHOTOGRAPHY.—MM. Paul and Prosper Henry have recently announced the discovery by means of photography of a new nebula in the Pleiades. It was first photographed on November 16 last, and, though it was again photographed on December 8 and 9, MM. Henry have as yet been unable to detect it by direct telescopic observation. The nebula is about 3′ in extent, and "très-intense." It presents a well-marked spiral form, and seems just to escape Maia. Its position is as follows:—R.A. 3h. 38m. 57s., Decl. 24° 1′ N.

GORE'S NOVA ORIONIS.—M. C. Wolf, who has examined the spectrum of this star, finds that the impression of the presence of bright lines which a first glance produces is not confirmed when the spectrum is more carefully examined under a high dispersion. The spectrum is simply that of the well-known third type, viz. a continuous spectrum crossed by a succession of bands, which terminate towards the violet in a very dark and sharp edge, and which gradually shade away towards the red. M. Wolf further believes that he was able, in the moments of best definition, to resolve the dark bands into lines. The Nova therefore does not appear to resemble the so-called "temporary" stars, but to be simply a variable of the same class as Mira Ceti. Prof. Millosevich gives its exact position for 1885·0 as follows:—R.A. 5h. 48m. 59·59s., Decl. 20° 9′ 13″·2 N.; or 1m. 25·21s. *f* and 5′ 59″·14 *s* of χ' Cygni. It is almost precisely due north of α Orionis, and distant from it 12° 46′ 20″.

THE ASTRONOMICAL PRIZES OF THE PARIS ACADEMY OF SCIENCES.—The Lalande Prize of the Académie des Sciences has been decreed to M. Thollon for his great map of the solar spectrum. This map, which has so far demanded four years of uninterrupted work, extends from *A* to *b*, and contains 3200 lines, 900 of which M. Thollon has been able to identify as of telluric origin. The Damoiseau Prize is reserved, no memoir having been offered for it. The subject proposed is the same as in former years: a revision of the theory of the satellites of Jupiter; a discussion of observations with special reference to the direct determination of the velocity of light; and lastly, the construction of particular tables for each satellite. The Valz Prize has been awarded to Dr. Spörer for his researches on sun-spots,—his discovery of the striking relationship between the distribution of the spots in latitude and the epochs of their maxima and minima receiving especial notice.

FABRY'S COMET.—The following ephemeris from elements he has recently computed is given by Dr. S. Oppenheim in the *Astr. Nach.*, No. 2702:—

Ephemeris for Berlin Midnight

1886	App. R.A. h. m. s.	App. Decl. ° ′ ″	Log. Δ	Log. *r*	Brightness
Jan. 9	23 36 33	21 12 51	0·2478	0·2523	1·40
11	35 0	20 38			
13	33 35	29 19	0·2514	0·2382	1·47
15	32 16	38 54			
17	31 4	49 23	0·2543	0·2236	1·55

BARNARD'S COMET.—Dr. J. von Hepperger has computed the following parabolic and elliptic elements for this comet:—

	Parabola	Ellipse
T	1886 May 6·2586	1886 May 4·5165
	° ′ ″	° ′ ″
ω	118 57 9·9	121 41 24·9
Ω	67 42 52·2	68 37 19·7
i	87 24 30·0	82 51 6·2
log q	9·695574	9·665966
log a		1·336444
log e		9·990625

Error of the middle place (O – C).

$$d\lambda = -2''\!.4 \qquad d\lambda = +4''\!.8$$
$$d\beta = -3''\!.9 \qquad d\beta = +1''\!.9$$

The following ephemeris is by Dr. A. Krueger:—

Ephemeris for Berlin Midnight

1886	App. R.A. h. m. s.	App. Decl. ° ′	Log Δ	Log *r*
Jan. 9	2 53 7	+ 9 41·1	0·3497	0·2112
11	49 7	10 2·7		
13	45 16	10 24·8	0·3383	0·2131
15	41 34	10 47·3		
17	38 2	11 10·2	0·3265	0·2155

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 10-16

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 10

Sun rises, 8h. 5m.; souths, 12h. 7m. 51·1s.; sets, 16h. 11m.; decl. on meridian, 21° 55′ S.: Sidereal Time at Sunset, 23h. 31m.

Moon (at First Quarter on Jan. 13) rises, 10h. 17m.; souths, 15h. 56m.; sets, 21h. 45m.; decl. on meridian, 4° 41′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 25	10 27	14 29	22 0 S.
Venus	9 41	14 55	20 9	9 43 S.
Mars	21 53*	4 24	10 55	5 21 N.
Jupiter	23 7*	5 5	11 3	1 5 S.
Saturn	14 44	22 54	7 4*	22 35 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

an.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
14	B.A.C. 830	6	19 9	20 11	75 343
16	θ^1 Tauri	4½	15 56	16 58	66 244
16	θ^2 Tauri	4½	15 58	16 56	45 264
16	75 Tauri	6	16 33	near approach	155 —
16	B.A.C. 1391	5	16 58	17 57	93 224
16	80 Tauri	6	17 5	near approach	337 —
16	81 Tauri	5½	17 20	near approach	338 —
16	85 Tauri	6	17 55	near approach	340 —
16	Aldebaran	1	19 48	20 49	122 248

Phenomena of Jupiter's Satellites

Jan.	h. m.		Jan.	h. m.	
11	4 4	II. ecl. disap.	14	23 53	I. ecl. disap.
13	1 29	II. tr. ing.	15	3 16	I. occ. reap.
13	4 15	II. tr. egr.	16	0 25	I. tr. egr.
13	5 24	I. ecl. disap.	16	4 59	III. tr. ing.
14	3 42	I. tr. ing.	16	7 45	III. tr. egr.
14	5 57	I. tr. egr.			

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich. Attention may be drawn to the Occultations occurring on the evening of January 16, and especially to that of Aldebaran.

Jan.	h.	
10	12	Saturn in conjunction with μ Geminorum and less than 1′ north of that star.
13	—	Venus at her point of greatest evening brilliancy.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.
U Cephei	0 52·2	81 16 N.	Jan. 13,	0 24 *m*
Algol	3 0·8	40 31 N.	,, 14,	2 22 *m*
			,, 16,	23 11 *m*
T Monocerotis	6 19·1	7 9 N.	,, 15,	17 0 *m*
ζ Geminorum	6 57·4	20 44 N.	,, 13,	2 30 *M*
U Monocerotis	7 25·4	9 32 S.	,, 10,	*m*
δ Libræ	14 54·9	8 4 S.	,, 12,	17 47 *m*
			,, 15,	1 38 *m*
U Coronæ	15 13·6	32 4 N.	,, 13,	1 24 *m*
U Ophiuchi	17 10·8	1 20 N.	,, 11,	1 39 *m*
			,, 11,	21 47 *m*
			and at intervals of	20 8
R Lyræ	18 51·9	43 48 N.	Jan. 10,	*M*
η Aquilæ	19 46·7	0 43 N.	,, 12,	5 0 *M*
δ Cephei	22 24·9	57 50 N.	,, 12,	2 30 *m*
			,, 13,	17 0 *M*

M signifies maximum; *m* minimum.

Meteor Showers

The cloudy weather generally prevailing at this season of the year greatly interferes with meteor-observation, but a number of fairly active radiants have been observed, the following amongst others:—From the constellation of the Lynx, R.A. 104°, Decl. 53° N.; from Coma Beren, R.A. 181°, Decl. 35° N.; from near χ Cygni, R.A. 295°, Decl. 53° N. Large meteors should be looked for on January 15, 16, and 17.

STANDARDS OF WHITE LIGHT[1]

THE experimental work of the Committee during the past year has not been extensive, as they had no funds at their disposal for experimental research, and they have been chiefly occupied with reviewing what has been done in the past and laying plans for future operations.

Lord Rayleigh has constructed an instrument which he calls a monochromatic telescope, by means of which the illuminated screens of a photometer may be examined, allowing light only of one definite colour to pass. It was hoped by Lord Rayleigh that experiment might show that, with some suitably-chosen colour, this instrument, used with any ordinary photometer, would, in comparing lights of different intensities and temperatures, give to each a candle-power which would be sufficiently accurate to represent for commercial purposes the intensity of the light. The Secretary has made some experiments at the Society of Arts, where he was kindly permitted to use the secondary batteries and glow-lamps; but the results so far are not definite enough to justify their publication.

Mr. Vernon Harcourt has been engaged on an investigation on the barometrical correction to his pentane standard, and on another concerning the possibility of using lamp-shades as a protection from air-currents. His researches are communicated independently to the meeting.

Capt. Abney and Col. Festing have continued their observations on the intensity of radiations of different wave-lengths from incandescent carbon and platinum filaments at different

[1] Report of the Committee, consisting of Prof. G. Forbes, Capt. Abney, Dr. J. Hopkinson, Prof. W. G. Adams, Prof. G. C. Foster, Lord Rayleigh, Mr. Preece, Prof. Schuster, Prof. Dewar, Mr. A. Vernon Harcourt, and Prof. Ayrton, appointed for the purpose of reporting on Standards of White Light. Drawn up by Prof. G. Forbes (Secretary).

temperatures, which will go far to assist the Committee in their work.

Other isolated experiments have been made by members of the Committee, which will be published in due course.

Most of the members have examined the experiments of the Trinity Board at the South Foreland.

Existing Standards.—A consideration of existing standards convinces the Committee that the standard candle, as defined by Act of Parliament, is not in any sense of the word a standard. The French "bec Carcel" is also liable to variations; and with regard to the molten platinum standard of Violle, it seems that the difficulty of applying it is so great as to render its general adoption almost impossible.

With regard to the so-called standard candle, the spermaceti employed is not a definite chemical substance, and is mixed with other materials, and the constitution of the wick is not sufficiently well defined. Hence it is notorious that interested parties may prepare candles conforming to the definitions of the Act which shall favour either the producer or consumer to a serious extent. In view of these defects of the standard candle, it is a matter of great importance that a standard of light should be chosen which is more certain in its indications.

The Committee have looked into the merits of different proposed standards, and the majority feel satisfied that, for all the present commercial requirements, the pentane standard of Mr. Vernon Harcourt—since it has no wick and consumes a material of definite chemical composition—when properly defined, is an accurate and convenient standard, and gives more accurately than the so-called standard candle an illumination equal to that which was intended when the Act was framed.

Yet the Committee, while desiring to impress the Board of Trade and the public with these views, do not feel inclined at present to recommend the adoption of any standard for universal adoption until, further information on radiation having been obtained from experiment, they may learn whether or not it may be possible to propose an absolute standard, founded, like electrical and other standards, on fundamental units of measurement—a standard which, for these reasons, would be acceptable to all civilised nations. They are, however, inclined to look upon the pentane lamp as an accurate means of obtaining an illumination to replace the so-called standard candle.

Proposed Experimental Researches.—Radiation is measured as a rate of doing work, and consequently radiation might be measured in watts. The illumination (or luminous effect of radiation) depends partly upon the eye, and is a certain function of the total radiation. This function depends upon the wave-length of the radiation, or on the different wave-lengths of which the radiation, if it be compound, is composed. This function of the radiation perceived by the eye is partly subjective, and varies with radiations of different wave-lengths and with different eyes. Thus the illumination cannot, like the radiation, be expressed directly in absolute measurement. But the connection between the illumination and the radiation can be determined from a large number of experiments with a large number of eyes, so as to get the value of the function for the normal human eye. This function, however, is constant only for one source of light, or, it may be, for sources of light of the same temperature. It appears, then, that, in the first instance at least, a standard should be defined as being made of a definite material at a special temperature.

The energy required to produce a certain radiation in the case of a thin filament of carbon or platinum-iridium heated by the passage of an electric current can be easily measured by the ordinary electric methods, and the radiation may be measured by a thermopile or a bolometer, which itself can be standardised by measuring the radiation from a definite surface at 100° C., compared with the same at 0° C. The electric method measures the absorption of energy; the thermopile measures the total radiation. These two are identical if no energy is wasted in convection within the glass bulb of the lamp, by reflection and absorption of the glass, and by conduction from the terminals of the filament. Capt. Abney and Col. Festing have come to the conclusion that there is no sensible loss from these causes. The Committee propose to investigate this further. This constitutes a first research.

No research is necessary to prove that with a constant temperature of a given filament the luminosity is proportional to the radiation, because each of these depends only upon the amount of surface of the radiating filament. It will be necessary, however, to examine whether with different filaments it be possible to maintain them at such temperatures as shall make the illumination of each proportional to the radiation. This will be the case if spectrum curves, giving the intensity o radiation in terms of the wave-length when made out for the different sources of light, are of the same form. Thus a second research must be undertaken to discover whether the infinite number of spectrum radiation curves, which can be obtained from a carbon filament by varying the current, are identical in form when the filament is changed, but the material remains so far as possible of constant composition.

It will be an object for a later research to determine whether, when the radiation spectrum curve of any source of light has been mapped, a similar curve can be found among the infinite number of curves which can be obtained from a single filament.

The next step proposed is to examine a large number of carbon or of platinum-iridium filaments, and to find whether the radiation spectrum curve of different specimens of the same material is identical when the resistance is changed in all to x times the resistance at 0° C. If this law be true, a measurement of the resistance of the filament would be a convenient statement of the nature of the radiation curve. If, then, a number of filaments were thus tested to give the same radiation spectrum curve, their luminosities would in all cases be proportional to their radiations, or (if there be no loss in convection, conduction, absorption, and reflection) proportional to the electrical energies consumed.

Thus it might be hoped to establish a standard of white light, and to define it somewhat in the following manner:—*A unit of light is obtained from a straight carbon filament, in the direction at right angles to the middle of the filament, when the resistance of the filament is one-half of its resistance at* 0° *C., and when it consumes* 10^9 *C.G.S. units of electrical energy per second.*

Since Mr. Swan has taught us how to make carbon filaments of constant section by passing the material of which they are composed through a die, it is conceivable that another absolute standard should be possible—viz., a carbon filament of circular section, with a surface, say, 1-100th sq. cm., and consuming, say, 10^9 C.G.S. units of energy per second.

Whether such standards are possible or not depends upon the experiments of the Committee. The probability of success is sufficient to render these experiments desirable.

Proposed Later Experimental Researches.—Should these hopes be realised, and an absolute standard of white light thus obtained of a character which would commend it to the civilised world, it would then become an object of the Committee to find the ratio of luminosity when the radiation spectrum curve of the standard filament is varied by varying the current, and consequently the resistance of the filament.

Thus, by a large number of subjective experiments on human eyes, a multiplier would be found to express the illumination from the standard lamp, with each degree of resistance of the filament.

A research, previously hinted at, would then be undertaken—viz., to find whether the radiation spectrum curves of all sources of illumination agree with one or other of the curves of the standard filament. It is not improbable that this should be the case except for the high temperature of the electric arc.

Should this be found to be true, then photometry would be very accurate, and the process would be as follows:—*Adjust the standard filament until its radiation spectrum curve is similar to that of the light to be compared.* (This would probably be best done by observing the wave-length of the maximum radiation, or by observing equal altitudes on either side of the maximum, the instruments used being a spectroscope and a line thermopile or a bolometer.) The total radiation of each is then measured at equal distances by the thermopile. The resistance of the filament is measured, and its intensity in terms of the unit of white light obtained therefrom by the previous research. The luminosity of the compared source of light is then obtained directly.

The Committee desire to be reappointed, and to enable them to carry out the researches indicated they ask for a grant of 30*l.*

PHYSICS AT JOHNS HOPKINS[1]

THE large and well appointed laboratories recently erected by the Trustees of the Johns Hopkins University for the Chemical and Biological Departments have by contrast made

[1] From *Science* of December 18, 1885.

the more evident the needs of the Physical Department, which has been obliged to occupy temporarily parts of four different buildings. The Trustees, recognising this need, are now erecting a building for a physical laboratory. The new laboratory is to be a handsome building of red brick, trimmed with brown sandstone, and will occupy a fine site about a block from the other University buildings, on the corner of a quiet little street midway between the more important streets, which carry the bulk of the traffic of that region. It will therefore be as free from disturbance from the earth-vibrations as could be expected in a city.

The building will be 115 feet long by 70 feet broad, and will have four stories besides the basement. In the centre of the building, and below the basement, are several vaults for instruments requiring to be used at constant temperature, also a fireproof vault for storage. In these vaults will be placed Prof. Rowland's dividing-engine, by which the diffraction-gratings are ruled, and the Rogers-Bond comparator, which has recently become the property of the University. In the basement will be rooms for the mechanical workshop, for furnaces, and for piers for instruments requiring great stability. The first floor will include the main lecture-room, which will accommodate 150 persons, and rooms for investigations by advanced students in heat and electricity. The second floor will contain mathematical lecture-rooms, studies for instructors, and a room for the mathematical and physical library of the University.

The elementary laboratory will be on the third floor, which will also have rooms for more advanced work. The fourth floor will contain rooms for special work in light.

There will be a tower on the south-east corner of the building, which will have two rooms above the fourth floor. The upper of these will be provided with telescope and dome, and will be a convenient observatory when great steadiness in the instruments is not required. There will be power in the building for driving the machinery in the workshop and for running the dynamo-machines. A large section of the building is to be made entirely free from iron. The sash-weights will be of lead, and the gas-pipes of brass. Brackets will be attached to the walls, on which galvanometers and cathetometers may be placed. In order to avoid the inconvenience of having piers go up through the lower rooms, and yet to secure steadiness, beams have been introduced into the floors, which reach from one wall to the other between the regular floor-beams, and do not touch the floor at any point. If, now, a table is made to rest on two of these beams, by making holes in the floor over them to admit the legs of the table, it is entirely undisturbed by any one walking over the floor, except by such motion as is transmitted to the walls. There will also be a small vertical shaft in the wall of the tower, running from top to bottom, in which a mercurial manometer may be set up.

The vaults for constant temperature have been built with double walls, so that a current of air may be drawn between them whenever desirable to prevent dampness. It is expected that the laboratory will be ready by October next.

The photographic map of the spectrum upon which Prof. Rowland has expended so much hard work during the past three years, is nearly ready for publication. The map is issued in a series of seven plates, covering the region from wave-length 3100 to 5790. Each plate is 3 feet long and 1 foot wide, and contains two strips of the spectrum, except Plate No. 2, which contains three. Most of the plates are on a scale three times that of Angström's map, and in definition are more than equal to any map yet published, at least to wave-length 5325. The 1474 line is widely double, as also are b_3 and b_4, while E may be recognised as double by the expert. In the region of the H line these photographs show even more than Lockyer's map of that region. Negatives have also been prepared down to and including the B group, and they may be made ready for publication, one of which shows eleven lines between the D lines. A scale of wave-lengths is printed on each plate, and in no case does the error due to displacement of the scale amount to one part in 50,000. The wave-lengths of over 200 lines have been determined to within one part in 500,000, and these serve as reference lines to correct any small error in the adjustment of the scale. The great value of such a map lies not only in the fact that it gives greater detail and is more exact than any other map in existence, but that it actually represents the real appearance of the spectrum in giving the relative intensities and shading of groups of lines, so that they are readily recognisable. The photographs were taken with a concave grating 6 inches in diameter, and having a radius of curvature of $21\frac{1}{2}$ feet, and the photographs were taken when the plate was placed directly opposite the grating; both the sensitive plate and grating being perpendicular to a line joining their centres, and placed at a distance apart equal to the radius of curvature of the grating, the slit being on the circumference of the circle, whose diameter is the distance between the grating and plate. With this arrangement, the spectrum is photographed normal for wave-lengths without the intervention of any telescopes or lens systems; and a suitable scale of equal parts applied to such a photograph at once gives relative wave-lengths.

Few persons have any idea of the perseverance and patience required to bring such a task to a successful issue. More than a year was devoted to preliminary experiments designed to discover the best mode of preparing the plates for the particular regions to be photographed. Hundreds of preparations were tested to find their influence on the sensitised plate, and the whole literature of photography was ransacked, and every method tested to the utmost, before the work of taking the negatives could begin.

The Rogers-Bond comparator, which has been already referred to as having been purchased by the University lately, is one of two instruments that were constructed in 1881 by Pratt and Whitney of Hartford, Conn. The general plan and requirements were made out by Prof. W. A. Rogers of Cambridge, and the drawings and details were worked out by Mr. George M. Bond, then a student at Stevens Institute. The comparator was designed for making exact comparisons of standards of length. The other similar comparator is owned by the Pratt and Whitney Manufacturing Company, and is used by them in testing and constructing their standard gauges.

The instrument consists essentially of two microscope-carriages, which slide on two parallel cylindrical steel ways between stops, which may be clamped at any point. A carriage entirely independent of the ways on which the microscopes slide supports the two bars to be compared, and is provided with means of accurate and rapid adjustment, by which the bars may be successively brought into position under the microscopes, and the lengths compared by the micrometers attached to the microscopes; or one microscope only need be used, and slid first against the stop at one end, and then against that at the other end. The instrument also affords great facility in determining fractions of a given length with any desired degree of precision. The instrument is one requiring the utmost skill in its construction, and it cost several thousand dollars to make it. A full account of this remarkable instrument is given in the *Proceedings* of the American Academy of Arts and Sciences for 1882–83.

K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Chancellor of St. Andrew's University (His Grace the Duke of Argyll) has given his sanction to a recent enactment of the University Court empowering the Senatus to admit to the Science Degrees of the University, students who may have received their education at University College, Dundee.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 17, 1885.—"A Preliminary Account of a Research into the Nature of the Venom of the Indian Cobra (*Naja tripudians*)." By R. Norris Wolfenden, M.D., Cantab. (from the Physiological Laboratory, University Coll., London). Communicated by E. A. Schäfer, F.R.S.

In this account the author refers only to cobra venom, the venom of *Naja tripudians*. The dried venom dissolved in water and filtered from accidental particles yields a solution, clear, and usually slightly acid. This solution contains a large amount of proteïd. Boiling produces a copious coagulum, and after removal of all coagulum by frequent filtration there is still much proteïd in the solution. A fresh solution of the venom is at once precipitated by neutral salts such as $MgSo_4$, NaCl, &c., and also by absolute alcohol.

The previous valuable labours of Sir Joseph Fayrer (*Proc. Roy. Soc.*, 1873, 1874, 1875, 1878), and Dr. Lauder Brunton and others, have dealt chiefly with the physiological side of the question, but have left the chemical nature of these snake venoms still undetermined.

Weir Mitchell and Reichert (*Med. News*, April 28, 1883; *Lancet*, July 21, 1883), working with the venoms of American snakes, have indicated in these venoms certain poisonous proteïds, the nature of which, however, is not fully elucidated. Wall's ("Indian Snake Poisons," Allen and Co., 1883) experiments and conclusions lead to the same view. Blyth (*The Analyst*, vol. i.) attributed the venom to an acid ("cobric acid") of deadly power. Gautier asserted that he had separated two ptomaïnes from Trigonocephalus and Naja venom. The author undertook this research with the object of determining whether the active venomous properties reside in the proteïd constituents or some other non-proteïd body or bodies. His work falls under the following heads:—

(1) The possibility of cobra-poisoning being due to "germs" or living organisms in the secretion.
(2) Its possible dependence upon an alkaloidal body.
(3) Its dependence upon some acid (cobric acid).
(4) Its dependence upon the proteids contained in it.
(5) The mode of action of these proteïds.

With regard to the first proposition, the author finds nothing in cobra poison which will grow under cultivation methods favourable for such organisms. The symptoms of the poisoning are entirely unlike bacillary infection, and resemble more the effect of some rapidly-acting chemical poison. With regard to the presence of "alkaloids" in cobra venom, the author made three examinations of the dried venom by the Stass Otto method, but failed to find any trace of an alkaloid. He thus confirms the results of Prof. Wolcott Gibbs, who examined cobra poison for Dr. Weir Mitchell, in search of "ptomaines," but stated that he could find no trace of such bodies. In reference to the "cobric acid" said to have been obtained by Blyth from cobra venom, the author remarks that as it is said to be crystalline, it will presumably readily dialyse. Searching the dialysates for such a body, the author has failed to meet with it. Dialysates that retain any toxic power do so by virtue of the proteid which they contain, since cobra venom, or the dialysate of cobra venom, loses its poisonous properties with the removal of its proteids.

The fourth proposition—viz. that the toxic power of the venom is resident in the proteïds, is the author's chief point, and on this subject he remarks as follows:—

The coagulum obtained by boiling the venom is harmless when injected into rats. The filtrate from the coagulum is toxic, though in less degree than the original solution. The author thinks this toxic power to be due to syntonin remaining in the solution. That it is due to proteïd is shown by the fact that, with the removal of this proteïd by acetate of lead, it is rendered harmless.

The dialysates of cobra venom which are toxic contain proteïd, but lose their poisonous properties when this proteïd is removed by boiling with ferric acetate.

The variable degree of toxic power of the dialysates is dependent on the length of time the dialysis has lasted, and thus upon the amount of proteïd that has passed through the dialyser.

From what has been said as to the non-existence of any poisonous acid or alkaloid in cobra venom, and also the diminution of toxicity on boiling solutions of the venom, and complete removal of poisonous properties on completely freeing the boiled venom from such proteid as has escaped coagulation by heat, and, further, as to the dependence of the toxicity of the dialysates upon the proteïd therein, there can be no further doubt that the toxic power of the venom is entirely due to its proteïds, and that it completely loses all poisonous power on the removal of these bodies.

The formerly reputed power of permanganate of potash as an antidote is explained by the action of this body upon albumens, which it converts into oxyprotosulphonic and other allied acids (according to Brücke and Maly) and it fails as an antidote within the body because it oxidises all albumens indifferently, without any selective power for the cobra proteïds.

The proteïds contained in cobra venom are—

(1) Globulin, which is obtained by saturation and shaking with $MgSo_4$, and which is coagulated in its solutions at 75° C. It is extremely toxic, and kills by involving the respiratory system, producing speedy asphyxia.

(2) Serum albumen, present in the filtrate from the $MgSo_4$ precipitate, and which is brought down on further saturation and shaking with Na_2So_4. It coagulates between 70° and 80° C. There is very little of it present, and it probably acts in a poisonous manner by producing a general and ascending paralysis.

(3) Syntonin, which is left in the filtrate after boiling the venom, and is also partially precipitated by $MgSo_4$, along with the globulin, and also appears in the dialysates, from which it is entirely removed by boiling with ferric acetate, or lead acetate. It possesses poisonous properties, chiefly like the globulin.

It is possible that some specimens of cobra venom contain a little peptone, though it can only be in faint traces. The bodies which Weir Mitchell and Reichert have described as peptone in Crotalus and Mocassin venoms are probably albumoses. That they are precipitated by dilute acetic acid, NaCl, and liquor potassa indicates this character. The "globulin," which they have described as dissolved by heating instead of coagulating, is also possibly a body of this nature. The complete removal of all proteids from cobra poison by boiling with ferric acetate, except in some specimens the very faintest trace (as indicated by metatungstic acid), shows that when peptone is present it is only in the smallest traces, and it is not constantly found in cobra venom.

In conclusion, the author desires to express his thanks to the Indian executive for readily acceding to the request of Mr. Vincent Richards, a member of the last Snake Commission, to supply him with the dried venom. The amounts received have, however, been small, making the research not only slow, but very difficult.

Victoria (Philosophical) Institute, January 4.—A paper by Mr. Boscawen, on the Abramic Migration, and the light thrown thereon by recently discovered Assyrian Inscriptions was read.

PARIS

Academy of Sciences, December 28, 1885.—M. Jurien de la Gravière, Vice-President, in the chair.—Obituary notice of the late M. L. R. Tulasne and his botanical work, by M. P. Duchartre.—Note on the new star in Orion recently discovered at Lord Crawford's Observatory, Dun Echt, by M. C. Wolf. From a study of its spectrum, which belongs to Class III., section *a* of Vogel, this would appear to be, not a temporary star like τ Coronæ discovered in 1866, but a true star hitherto undetected.—On the movement of the molecules of the "solitary wave," by M. de Saint-Venant.—Researches on the functions of Wrisberg's nerve—complementary note, by M. Vulpian.—Researches on the real origin of the secreting nerves of Nuck's salivary gland, and of the labial salivary glands of the dog, by M. Vulpian.—Observations on the structure of the vascular system in the genus Davallia, and particularly in *Davallia repens*, by M. A. Trécul.—On the respiration of plants outside the living organisms, in connection with M. Regnard's recent communication, by M. Ad. Chatin.—On a new theory of algebraic forms (continued), by Prof. Sylvester.—Report on M. Mestre's claim of priority of discovery in connection with MM. Napoli and Abdank-Abakanowicz's integraph, by the Commissioners, MM. Bertrand and Jordan. To a certain extent M. Mestre's claim is allowed; he appears entitled to the credit of the general idea of the apparatus, all the details of which must, however, be accredited to M. Napoli.—Letter on the proposed appointment of a special Commission to study the subsidence of the land along the coasts of the English Channel, by the Minister of Public Instruction.—On the relative frequency of the spots on the two hemispheres of the sun, by M. Spörer. Between the years 1880-82 the spots occurred most frequently in the northern hemisphere (56 per cent.), but from 1882-85 they were most frequent in the southern, being last year in the proportion of 69 to 30 per cent.—On a unique method of determining the constants of the altazimuth, and of M. Lœwy's recently-invented meridian lunette "à grand champ," by M. Gruey.—Observations of Barnard's comet made at the Observatory of Bordeaux, by MM. G. Rayet, Doublet, and Flamme.—Observations of Fabry's comet made at the Observatory of Bordeaux, by MM. G. Rayet and Flamme.—Elements of Fabry's comet, by M. Gonnessiat.—Note on the secular diminution of the obliquity of the ecliptic, by M. F. Folie.—On the potential energy of two ellipsoids mutually attracting each other, by M. O. Callandreau.—On the doubly periodical functions of the third species, by M. Appell.—Note on the effects of the rheostatic machine of quantity (two illustrations), by M. Gaston Planté.—A new application of the principle determining the transmission of power to a distance by means of electricity, by M. Manceron.—Application of the numerical laws of the chemical equilibria to the dissociation of the hydrate of chloride, by M. H. Le Chatelier. The principles here developed are directly applicable to all the hydrates of gaseous bodies, and to a large number of other compounds, such as the alkaline bi-carbonates, with which the author is at present occupied.—Action of some deoxidising agents on vanadic acids, by M. A. Ditté. It is shown that, when subjected at a high temperature to the action of hydrogen, sulphur, arsenic, phosphorus, and some other reducing agents, vanadic acid may, according to the circumstances, lose a greater or less quantity of oxygen.—Note on the preparation and physical properties of the pentafluoride of phosphorus, by M. H. Moissan.—Note on the combinations of the trichloride of gold with the tetrachlorides of sulphur and selenium, by M. L. Lindet.—Thermic researches on glyoxylic acid ($C_4H_4O_8$), by M. de Forcrand.—On the oxidation of sebacic acid, by M. H. Carette.—On a new means of testing the purity of volatile substances, by M. E. Duclaux.—On the normal character of the morbid process developed by tuberculous inoculations, by M. G. Colin.—Remarks on the character of the glycogen observed in the ciliated Infusoria, showing that it is in every respect analogous to that developed in the liver of higher organisms, by M. E. Maupas.—A physiological study of acetiphenone, by MM. A. Mairet and Combemale.—On the dialytic properties of the membrane of the cyst in *Vorticella nebulifera* and other Infusoria, by M. F. Fabre.—Note on the polychete Annelidæ found on the French coast, district of Dinard, by M. de Saint-Joseph.—On the traces left by the Quaternary glaciers in the cave of Lombrives, Ariège Valley, by M. E. Trutat.—Remarks on the first sheets of the new geological map of France, prepared to a scale of 1 : 500,000, by MM. G. Vasseur and L. Carez. This work, which is to be completed during the course of the year 1886, will comprise altogether forty-eight sheets, of which fifteen have already been issued. These include the south coast of England, the greater part of Belgium, Luxemburg, the Rhine to Bonn and Frankfort, Alsace-Lorraine, the eastern and central parts of the Paris Basin, and the neighbourhood of Bordeaux.—Chief results of the systematic researches made in Sweden since the year 1873 on the upper atmospheric currents, by M. H. Hildebrandsson.—Note on the northern limit of the south-west monsoon in the Indian Ocean, by M. Venukoff. It appears from M. Prjevalsky's recent voyage to Northern Thibet that the limit of the south-western monsoon coincides approximately with the 37th parallel of latitude, and stretches west and east from about the head-waters of the Oxus and Tarim Rivers to the meridian of Lang-chew, capital of the province of Kan-su, in West China.—A reply to M. Bourquelot's recent note on interverted sugar, by M. E. Maumené.—Note on the guano of Alcatras, by MM. A. Herbelin and A. Andouard.—Reply to M. Cartailhac's objections on the human remains and pottery recently found in the cave of Nabrigas, by MM. Martel and de Launay. The authors deny the possibility of a post-Quaternary disturbance of the cave, and consequently maintain the conclusions already formulated on the significance of these discoveries.—The death was announced of M. Tulasne, Member of the Botanical Section, who died at Hyères on December 22, 1885.

VIENNA

Imperial Academy of Sciences, October 8, 1885.—On the establishment of a homogeneous magnetic field on the tangent galvanometer for measuring stronger currents, by G. A. Schilling.—On the blood-circulation of the ganglion-cell, by A. Adamkiewicz.—Determination of the orbit of the planet Ida (243), by N. Herz.—On the energy of the yeast-cell, by G. Czeczetka.—On a new method for the determination of phosphorus in pig-iron and steel, by W. Kalmann.—On Brooks's comet of September 2, 1885, by E. Weiss.—Astronomical researches on the eclipses noted by Hebrew writers: i. the Biblical eclipses, by E. Mahler.

October 15.—Contributions to our knowledge of sulpho-hydantoins, by R. Andreasch.—On the disposition of karyokinetic figures in the central nervous system and in the retina of adder-embryos, by L. Merk.—Researches on strychnine, by F. Loebisch and P. Schoop.

October 22.—On some applications of the principle of apolarity, by B. Igel.—Studies on quercetin and its derivatives, ii., by J. Herzig.—On some derivatives of phloroglucin, by the same.—On rhamnin and rhamnetin, by the same—Results of an embracing computation of the elements of all central and partial eclipses of the sun—8000—which have occurred in the period − 1207 November 10 (Jul.) till + 2161 November 17 (Greg.), and of all total eclipses of the moon—5200—in the period from − 1206 April 21 (Jul.) till + 2163 April 12 (Greg.), by Th. von Oppolzer.—On prophetic eclipses, by E. Mahler.

November 5.—On the fat of cochineal, by E. Raimann.—On *Tosoraphinia texta*, Rœm. sp., and on *Scytalia pertusa*, Reuss. sp., from the environs of Raudnitz (Bohemia), by J. Fahalka.—On Crocodilida from the Miocene of Styria, by A. Hofmann.—On the application of the gravity of a rolling body as a motive power, by J. Burgaritzki.—On a new mechanical principle of the force hitherto called gravitation, by W. Bosse.—A preliminary note on the zodiacal light, by T. Unterweger.—Sketch of a theory of the moon, by Th. von Oppolzer.

STOCKHOLM

Academy of Sciences, December 9.—Remarques concernant un cas special du problème des trois corps, éclaircies par une première approximation pour les mouvements de la planète Hécube (108) sous l'influence du soleil et de Jupiter, by Dr. Paul Harzer.—On Schefferite from Långbau and Pajsberg, by Dr. G. Flink.—Observations on the meteoric showers, November 27, 1885, by Prof. H. Hildebrand.—Sur la théorie des ensembles, by Prof. G. Cantor.—Remarks on this paper, by Dr. G. Enström.—New and imperfectly-known Isopoda, by Dr. C. Bovallius.—Systematic list of the family Asellida, by the same.—The laws of the atomic weights, by Dr. Y. R. Rydberg.—On double oxalates of platinum, by Herr H. G. Söderbaum.—On rocks composed of pyroxene and amphibole in Central and Eastern Småland: (1) classification and description of the rocks, by Dr. F. Eichstädt; (2) Myrmecological studies, by Herr G. Adlerz.—On pyramidal stones (Dreikanter) from the Cambrian formation of Sweden, by Prof. A. G. Nathorst.

CONTENTS

THURSDAY, JANUARY 14, 1886

THE VEGETABLE GARDEN

The Vegetable Garden. Illustrations, Descriptions, and Culture of the Garden Vegetables of Cold and Temperate Climates. By MM. Vilmorin-Andrieux, of Paris. English Edition. Published under the direction of W. Robinson, Editor of the *Garden*. 8vo, pp. 601. (London: Murray, 1886.)

THIS is an English edition of a book which under its original title of "Les Plantes Potagères" has been received with encomiums alike by gardeners and by men of science. Professedly addressed solely to practical gardeners, it is so conscientiously elaborated that it has become, and will remain, a standard book of reference for the naturalist. This is a great triumph for the author, M. Henry Vilmorin. The botanist would at first glance naturally be disposed to consider such a book as at best merely a descriptive trade catalogue of an eminent seed firm, and the biologist might perhaps look askance at the notion of deriving any information of value for purposes of pure science from its pages. But on further examination, it will be found that the merely trade element is ignored, and that the descriptions of the several plants treated of are so carefully drawn up that they will as far as they go meet the requirements of the naturalist.

These descriptions are founded, as we have personal reasons for knowing, not only on the observation of plants growing in the author's seed grounds near Paris, but also on the inspection and comparison of the same or allied forms in the market gardens of Europe generally. The experimental garden of our own Royal Horticultural Society at Chiswick has been utilised in this way, while even the smaller market gardens in the vicinity of Continental towns have not been left unvisited.

Those who have not previously attended to the matter will possibly experience a feeling of surprise at the large number of varieties here enumerated. They are familiar, perhaps, with broccolis and cauliflowers, though they would find it hard to distinguish between them. They might pick out savoys from cabbages, but for the most part they would roughly class such things as "greens," and not pursue the subject further.

While all vegetables are grown for food, subdivisions may be created among them in accordance with special requirements. There are, for instance, the supply of the markets, the exigencies of the exhibition table, the demands of private establishments, and, we might add, the demands resulting from the eager competition of commercial men. The rule of the survival of the fittest has to be applied with special modifications to each of these cases.

Quality is not so much an object of solicitude to the market grower as early or quick growth and abundant produce. The man who can send his produce to market earlier than his fellows has a distinct advantage, and thus it is that foreign competition is so serious an affair for the English grower. Not only from the Channel Islands but from the South of France and Algeria come immense quantities of salads, vegetables, and fruits to our markets. The smaller cost of labour and the high prices obtained balance the expense of the long transit. The home-grower, on the other hand, can continue the supply after the Continental sources have become exhausted, and thus in some cases late varieties are preferred by our growers. But in any case for market purposes on a large scale—for the supply of the general public—the crops must be large, and hence it is that a market gardener will grow what he knows to be "a good cropper" rather than a plant of better quality but which is less productive.

The exhibition tables at our flower and fruit shows, although they foster a good deal of fantastic extravagance, nevertheless effect much good by allowing of the exhibition of numerous varieties, so that the grower may see which is good and which less good, or which is specially suited to his conditions and requirements. They also stimulate the zeal of the growers and powerfully promote good cultivation. This must have been remarked by many at the exhibitions held by the Royal Horticultural Society for the last two years in connection with the "Health" and with the "Inventions" Exhibitions. Such displays render great services to cottagers and others by bringing under their notice new and improved varieties often just as easy to cultivate as those of inferior quality. On the other hand, the "prize system" too often leads to the devotion of an inordinate amount of attention to mere size and external appearance. The bigger and the more symmetrical the exhibit the better the chance of a prize. The huge roots seen at the cattle shows, for instance, are in their way marvels of culture, but their feeding value is considerably less in proportion to others of more moderate size and perhaps less shapely appearance. Water, rather than starch and sugar or nitrogenous compounds, is the predominant element in these overgrown products. When such vegetables as these get prizes the judges are to blame and the societies are doing their work badly.

In private establishments the case is different. While the supply must of course be adequate, the quality of the vegetables is a matter of greater consideration than the mere quantity.

The different requirements we have alluded to entail a corresponding variation in the amount and character of the supply. In addition differences of soil, climate, and other local conditions necessitate other variations. What is suitable for one place is not so for another. When these facts are considered, the wonder that there should be so many varieties will pass off. In most instances these plants have been in cultivation for centuries. They exhibit, some more, some less, the tendency to vary which is the common attribute of all creatures. Having secured a variation suitable for his purpose, whatever it may be, the object of the grower is to fix it and perpetuate it, and only those who have visited our great seed-farms know with what jealous care and with what labour this is effected. When, as is the case with the Brassicas, the facilities for intercrossing are great, the difficulty of preserving a pure stock is intensified.

For scientific purposes, for the purpose of ascertaining the nature and possible range of variation within limited periods, and either under the same or under different conditions, a visit to an experimental garden like that at Chiswick, or to one or other of the great commercial seed-farms, is most instructive.

This aspect of the matter is treated of in the original preface, but we regret to see that it has been omitted from the English version. This is an injury to the book from the point of view of science, and an injustice to the reader, who would value the opinion of so careful an observer as M. Henry Vilmorin. It must suffice here to say that although he recognises the "unstable and perpetually changing characters" of plants, especially when submitted to cultivation, this variation, vast as it is, does not, in his opinion, affect either the number or the position of "legitimate species." M. Vilmorin's natural qualifications and his exceptional opportunities, of course, entitle him to be heard with very great respect, but we suspect most English botanists and cultivators would arrive at different conclusions from the same premises.

Of the value of this book to practical men it is not necessary to speak here: it is because it offers so valuable a storehouse of carefully observed facts of value to the biologist that we have alluded at such length to a volume which might at first be thought to be of interest to gardeners only, but which, we may repeat, is eminently worthy the attention of all those interested in the vast questions connected with variation and inheritance.

There are many points on which we should have liked to have commented, but the exigencies of space forbid. We have only to add that the translation has been well done by Mr. W. Miller, that some practical details have been added to adapt the book for English use, and that a very copious index is provided.

MAXWELL T. MASTERS

PROFESSOR MARSHALL ON THE FROG

The Frog; an Introduction to Anatomy and Histology. By Prof. A. Milnes Marshall, M.D., D.Sc., M.A., F.R.S., Beyer Professor of Zoology in Owens College, Manchester. Second Edition. (Manchester: J. E. Cornish, 1885.)

THE teaching of biological science never received a greater impetus than that which took its origin in the establishment, fourteen years ago, of the laboratory at South Kensington, now associated with the Normal School of Science and Royal School of Mines; and the publication, some three years later, in connection therewith, of Huxley and Martin's "Elementary Biology," marks an epoch no less definite or important. The large number of teaching laboratories which have since been founded, wherever the English tongue is spoken and even on the Continent, have almost without exception been modelled directly or indirectly upon the Kensington plan. Practical directions for working have been issued in connection with most of them, compiled along the lines of Huxley and Martin, but specially adapted to the requirements of the individual schools. Of these, most are still alone used in the dissecting rooms for which they were written; some few have, however, been published separately, the volume before us being one of their number.

The author's name is a guarantee of the thoroughness of the work, and he has done well in taking such a prototype for a guide. We read in the preface that the book is a first instalment, to be followed by a second dealing with "types of the principal zoological groups;" as the ultimate success of the project will depend upon the selection of these types, and especially upon the evenness of balance maintained in dealing with them, we reserve full criticism until the completed work is before us.

The present edition is mainly noteworthy for the introduction of illustrations—fifteen in number. The original ones are for the most part somewhat rough, though accurate in detail, and they have the merit of representing the structures as they will meet the eye of the student. Fig. 10, however, would bear recutting, for if the bones are "represented black" why not the columella-auris; and continuity should certainly be shown between the brain and very sketchy labyrinth. The maxillo-palatine commissure—described (p. 84) in its proper place—should also find a representative in Fig. 13, and in connection with the renal-portal vein of Fig. 4 afferent renal branches might be advantageously introduced. The relation of the mesentery to the kidneys in Fig. 2 also needs looking into.

The text bears the mark of a writer in full sympathy with the difficulties which beset a beginner; more importance might, however, well be given to a consideration of those matters of symmetry, locality, and general utility, which must be mastered before studying anatomy proper. The customary restrictions put upon at least the terms *anterior*, *posterior*, *lateral*, should be clearly set down in addition to those given on p. 13 and elsewhere, and the positions of the organs should be described accordingly. If this were so, the description of the liver given on p. 17 would, for example, be more accurately rendered than it is.

It would facilitate the demonstration of the bile ducts in so small an animal, if the student were directed to simply squeeze the gall-bladder after having opened up the intestine, instead of risking the insertion of a destructive bristle as advised on p. 20.

A special feature has been made of the histological section of the work, but, granting its thoroughness, we would fain see some of the frog's tissues retained for those supplemented from other animals, especially in the case of bone, where so highly instructive an example as that of the long bone is to hand. In describing the nerve fibre the nodes of Schmidt have been overlooked, but here our author is not alone; considering the years that have elapsed since their discovery, it is strange that they should only recently have found mention in our English text-books. Reflecting on the doubtful nature of the so-called non-medullated nerve-fibres, it is a pity that the ultimate ramifications of a medullated fibre in so out-of-the-way a place as the cornea should be made (p. 89) to do duty for them.

The book is neatly and carefully got up, but a future edition should not be published without an index. The description of the mesentery in relation (p. 18) to the alimentary canal, and those of the attachments of the corpus adiposum and testes (p. 17) might well be much modified; and the like is true of the statement that the skeleton gives (p. 45) "precision to the movements" of the body. The heading (p. 48), "peculiar vertebræ," is bad, and olfactory *sacs* reads on p. 49 "olfactory nerves," in error. A somewhat remarkable typographical error is the "mpanic cavity" of p. 98.

In conclusion, we would take exception to the references (pp. 28 and 74) to the suppressed aortic arches of the embryo and to the mode of development of the nervous axis, unless their introduction bears upon the lecture scheme adopted at the Victoria University. If so, well and good, but if not, we are of opinion that such supplemental statements should be inserted, in a book of this kind, as footnotes or their equivalents. It is sufficient that the beginner should realise that three pairs of aortic arches exist in the adult, alone under consideration.

OUR BOOK SHELF

Methods of Research in Microscopical Anatomy and Embryology. By C. O. Whitman, M.A., Ph.D. (Boston: S. E. Cassino and Co.; London: Trübner and Co. 1885.)

WITHIN the last few years a number of new methods have been suggested for use in microscopical, and more particularly embryological, research, and a glance at almost any one of the recent memoirs on these subjects will serve to show how much is due to the employment of new methods. It is, however, extremely important not to lose sight of the fact that complicated methods are exceedingly likely to produce false or misleading appearances. To carry on successfully any microscopical research it will probably be necessary to invent new methods or at any rate modify old ones to suit the exigencies of the case. To do this an acquaintance with the methods which have been used by previous observers is necessary, and in addition a clear idea of such general principles as it is possible to formulate with regard to the action of various classes of reagents upon various tissues.

A great number of the new methods have been described, and this often in a few words only, in special memoirs, so that they are often overlooked.

"Hitherto," says the author of the work before us, "most of our standard books of reference on methods have been rather complex in character, dealing with the microscope and technical methods as subordinate and introductory to the main subject of histology."

With regard to certain special methods there appears unfortunately to be a reluctance on the part of their inventors to reveal what they thus make a sort of trade secret, "withholding it on the ground that others are not entitled to the advantages of your experience." Dr. Whitman in his present work has sifted the numerous methods which have been suggested, and has given histologists the benefit of his great practical experience in rejecting some while recommending others; he has also endeavoured to formulate as many general principles as possible, though of course there is more to be done in this respect, our knowledge being at present insufficient to generalise to any great extent.

We notice with regret a slight tendency in the work before us as well as certain histological schools to neglect almost entirely the older and simpler methods of cutting sections. Serial section-cutting is now such an important item in all morphological work that it is apt to be used to the exclusion of older methods, which give in many cases undoubtedly better histological results.

Dr. Whitman has also collected a large number of most important observations with regard to the best method, time, and place of obtaining material; these are of course very incomplete, but it is to be hoped that he will see his way towards continuing them, and that others will follow his excellent example.

Alternating Currents of Electricity. By Thomas H. Blakesley, M.A. "*Electrician* Series." (London: Published at the Office of the *Electrician*, 1885.)

THIS is a very unsatisfactory little book; indeed it is difficult to find anything favourable to say of it, except that it is concerned with a subject which is of considerable importance, and which might be treated in an interesting and instructive manner. It is a reprint of papers, originally published in the *Electrician*, on Alternating Currents of Electricity, and professes to deal with various problems connected with them by geometrical methods. But the methods are long and intricate, and the work is not well done;—carelessly written and printed in the beginning, the style remains unchanged. The errors in form are numerous, the figures are not good, and geometry and algebra are mixed up in formulas in the most puzzling and irritating way. We find commas between the factors of products (all through pp. 11, 12, 13), and diagrams in which the letters are illegible in several places. In one investigation covering three or four pages, we have the letter *C* used for capacity of a condenser, for electric current, for the sum of a series of cosines, and for designating points in the diagrams. In fact the whole book is full of confusion, and is a model of what mathematical writing ought not to be; while we cannot imagine that it will prove useful or even intelligible to the telegraph engineers for whose benefit we may suppose it was put together. J. T. B.

Third Annual Report of the New York Agricultural Experiment Station, for the Year 1884. (Albany, N.Y.: Weed, Parsons, and Co.)

THIS Experiment Station was established by an Act of Legislature passed in 1880, and amended in 1881. The management is intrusted to a Board of Trustees, who appoint a director, horticulturist, botanist, chemist, stenographer, farmer, and assistants. Such an organisation must be considered as a step in advance beyond anything yet done in this country, being a direct action on the part of the Government to promote the exact knowledge of agriculture. This is the main point we desire to bring before the readers of NATURE. Among the many voices raised on behalf of technical instruction of artisans and others engaged in industrial pursuits, or of musicians and artists, few are to be heard in favour of the promotion of exact agricultural knowledge. The Americans are wiser, and are establishing what they call "experiment stations" in various parts of their wide territory. A few of the objects of investigation at present occupying the attention of the staff of the New York Station may be enumerated as follows:—(1) Fertiliser analysis; (2) sample orchards containing single trees of each known variety; (3) soil temperatures at various depths; (4) digestibility of various foods; (5) germination of commercial seed; (6) a study of maize; (7) root-distribution by root-washings; (8) milk; (9) diseases of plants. These sections furnish material for 418 pages, abounding in tables of results of great practical value. The pains taken in thoroughly working out the conditions of milk-production in the case of two cows, "Meg" and "Gem," are evidence of great activity and zeal. The weight of the cows was taken daily from September 17 to November 12. The weight of food consumed, the accurate analysis of the food, the *daily* weight of solid and liquid excrements, the *daily* yield of milk, the *daily* analysis of the milk,—all this carefully and punctually recorded, and fixed in tables, is a work of great importance, not only as bearing directly upon dairying, but having likewise a physiological value. Such constant daily observations are not only essential, if the experiment is to be of any practical value, but must be beyond the efforts of practical farmers, who really ought not to undertake such investigations. But the value to the community at large when such experiments are conducted quietly and regularly by persons specially set apart and paid to carry them out cannot be overrated. They must not be attempted by ordinary dairymen in ordinary stalls, and with ordinary business appliances, but can only be carried out by trained hands, in specially constructed stalls and with special arrangements, all of which must be carried out at a *loss*, which loss is the reason for an endowment. It is hard to say whether the perusal of such a Report as now lies before us impresses most with admiration for American activity or regret for English supineness. JOHN WRIGHTSON

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Major Greely on Ice, &c.

IN the long and interesting address of Major Greely at the special meeting of the Royal Geographical Society, held ten days ago, with the object of hearing an account of some of his proceedings during his painfully memorable Arctic expedition, the traveller dwelt so largely upon the conditions of the ice on the open Polar sea, &c., that one was led to believe that he was talking *at* opinions—spoken or written—by some one adverse to his own; possibly those given by myself in the communication published in NATURE of December 10 last may have been meant. Should this be so, anything that Major Greely has said does not in the slightest degree affect the statements made by me in the above-mentioned letter.

Major Greely tells us that Hayes, as well as *Kane* (it should be *Morton*), saw "an open Polar basin." Payer, in as high or a higher latitude at Franz Josef Land, saw, at a much earlier date in spring than Hayes and Morton did, a larger pool of open water, with "myriads" of water-fowl, but did not think of calling it an "open Polar basin," or part of one.

This idea of a great open Polar sea is almost, if not wholly, confined to our American cousins, where it seems to have taken firm root for at least thirty years past, and has, I should imagine, a spiritualistic origin, for Dr. Kane was a believer in spiritualism.

With the fear of appearing tedious, I shall quote briefly the perfect meaning, if not the exact words, of part of a letter which a distinguished spiritualist, Major ——, sent to me prior to one of my Arctic expeditions. In this letter I was told that Franklin was still alive (clear proof had been obtained that he had been dead some years before the date of a *part* of this letter), and was residing at 132 (?), St Peter Street, in a seaport town called Joppa, having a population of more than 100,000 persons, on one of the lands near the Pole!

There was a large population, the Government Republican, and a fine, healthy, and salubrious climate. "These *people were descendants of one of the lost tribes of Israel*"!

The postscript was curious, and written at a later date than the letter itself, immediately after the death of Dr. Kane, as follows:—"Have just had communication with the spirit of Dr. Kane, whose first visit after death was paid to Franklin in Joppa, where he was still alive and well, but praying to get home."

Major Greely seems to confound two forms of ice having very different origins—namely, the floeberg, of which I have already said enough elsewhere, and the freshwater-ice, which, he says, is derived from the ice-caps of far northern lands, a mass of which he saw, having very considerable extent and "a thickness of one-sixth of a mile! with a deep valley containing a number of boulders."

This great mass of ice, 880 feet thick, with valley and rounded stones, may have been readily formed on the shores of one of the high headlands—one of which is named as having an altitude of nearly 3000 feet—along the northern portions of which Lieut. Lockwood skirted during his sledge journey on the coast of Greenland.

True, I was never in these high latitudes, but a person may sometimes be permitted to reason from analogy, as I shall attempt to do.

In 1848 I saw on the northern shore of America, in lat. 68° 40′, not far from the Coppermine River, a snowdrift against a cliff about 100 feet high, and in 1849 I and my party were detained at the same place for a good many days, during which we had ample time and opportunity to examine this snowdrift, nearly all of which was converted into ice that seemed permanent, except when parts broke off and floated away.

The slope of this snowdrift tapered towards the sea with so gentle a descent that our boat was easily hauled upon it to protect it from the ice-pack, and we with great facility carried our baggage up the ascent, and pitched our tent on the top of the cliff. A part of this snow-drift ice had broken off and drifted away, showing a very distinct stratified section, similar to that described by Dr. Moss and Major Greely.

The height of this section above sea-level was only, as far as I can remember, about 10 or 12 feet, for the water is shallow on this coast,[1] but, if Major Greely's measurements are correct, the

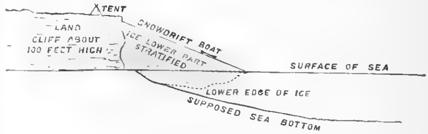


FIG. 1.—Actually seen by J. Rae in 1849, at a headland north of Coppermine River, lat. 68° 40′.

water close to the Greenland shore must be pretty deep—at least 100 fathoms—so as to float ice one-sixth of a mile thick.

My contention is that, if in latitude 69° a drift-bank of snow and ice is kept up from year to year against a cliff 100 feet high, the same thing may take place in latitude 82° to a far larger extent, where the shore is 2000 feet high, steep or precipitous, and the sea deep, so that masses of ice 800 or 900 feet thick may break off and float away.

That such great sloping snowdrifts do occur on the northern Greenland coast was proved by the difficulty met with by one of the officers of the English Expedition in travelling along them in 1876 with sledges, being forced to do so in many places by the rough ice outside, which stopped the way along the level floe.

As regards boulders, they are to be found of various sizes, more or less numerous, almost everywhere on Arctic lands high above the present sea-level, and they might have been transported to the "valley" spoken of by Greely in other ways than that supposed by him. They may have been moved downwards very slowly, by the alternate freezings and thaws of the snow and ice round them, by storms and snowdrifts, then down the slope of the valley to its lowest level, or they may have been carried by one of those streams of water similar to that mentioned as running down over the snow-caps of Grant Land. In fact, all that is wanted for this purpose would be two high,

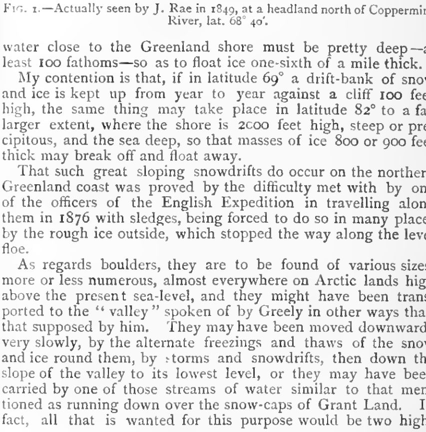


FIG. 2.—Supposed headland on the northern part of Greenland, about 1500 feet high. Greely says these headlands (or one of them) are nearly 3000 feet, having a northern or north-eastern aspect.

steep bluffs, with a deep narrow ravine between. The bluffs would give the thick masses of snow and ice-drift, and the ravine might form the bed of a stream carrying stones into the valley.

Neither Dr. Moss nor Major Greely, as far as I have noticed, have accounted for the very distinct stratification seen in the form of ice described. In all parts of Arctic America where I have been, a fall of snow is usually either accompanied or followed by a gale of wind more or less strong, chiefly from one

[1] In the very rough sketch sent, the water is made to appear much too deep; in fact, there is no pretence at correct proportion of heights and distances.—J. R.

direction, with thick snowdrift, which cuts away earth and sand in minute particles from the windward side of any hill or rising ground in its course, and these particles are carried along until they find a resting-place under the lee of some steep bank or cliff.

These foreign substances, when mixed with a great depth of snow, are not readily seen, but when the spring evaporation and thaws remove a great part of the snow, a stratum—more or less thin—of coloured matter, is visible on the surface, and this marks clearly the stratum or formation of one season. No doubt, sometimes, if there happen to be a minimum of snowdrift during the winter, followed by an unusually warm summer, all the winter deposit of snow may be removed, and the earthy deposit (naturally smaller than usual) will be added to that of the previous year.

It may be asked why I did not speak of these matters in Major Greely's presence at the meeting of the Geographical Society? This is easily explained: Major Greely's address was so long that little time was left for discussion, and this time was most properly given to the officers (four of whom were present) of the English Government Expedition of 1875–76, who, to my surprise and amusement, let the astute citizen of the United States have things pretty much his own way. In fact, one of these officers made matters rather worse than better by what he said. JOHN RAE

4, Addison Gardens, Kensington, W., January 1

Hydrophobia—A Further Precaution

IT may be taken as an accepted fact that mongrels are more liable to rabies than well-bred dogs, both from the ill-treatment they commonly receive, and from the unnatural mingling of species that has led to their production. Statistics show that over 90 per cent. of mad dogs are retrievers, or animals so-called. In addition to these two points, it can be safely maintained that no kind of dog gives birth to so many mongrels as the retriever. Pointers, setters, terriers, and hounds will not readily breed from dogs of another class, but the reverse is true of the retriever, and the result is the production of a horrible progeny that ought to be immediately destroyed. Owners of a kennel of sporting dogs are constantly subjected to the annoyance of one of their true-bred retrievers having a litter of pups that only resemble retrievers in their coats. I would therefore suggest that the Retriever Stud Book should be kept by a Government official, and that all owners of retrievers should be obliged to send notice to him when a litter arrived; and that the police should be empowered to destroy any retriever whose owner was not provided with a certificate of registration. A few inspectors of litters could travel the country, and at a cost of a few hundreds a year prevent the development of countless mongrels—valueless for sporting purposes, hideous to look at, and sure promoters of canine madness. H. M. TOMLIN

Rotation of Mars

PROF. BAKHUYZEN is right in regard to the number of days counted in error by Kaiser in comparing Hooke and Huyghens with recent observations. I wrote away from books, and with no means of determining whether Kaiser had made Hooke's observation a day too early or a day too late in comparing it with Huyghens's—which was what in reality he did. I saw that three days' correction would about bring matters right, and knew that in 1873 I *had* brought matters right; so concluded that was the way. But, being in London for a few days, I have looked up my paper of 1873, and find that the correction was obtained by omitting two days from Kaiser's count between Huyghens and himself, and adding one day to his count between Hooke and Huyghens.

I have not seen Prof. Bakhuyzen's paper, and the pressure of more serious business (life-duties) prevents me from giving time to such examination of it as I gave to Kaiser's in 1873. The results, however, were and are before me. It was natural I should infer that he had taken Kaiser's results as they stood. For, the comparison of either Hooke or Huyghens, using Kaiser's own dates and estimates (following him, in fact, in everything except his clerical errors in regard to the New Style date for Hooke's observations, and to the number of days in 1700 and 1800), gives no such results as Prof. Bakhuyzen has presented. Kaiser made the interval between November 1, 1862, 6h. 10·1m., and August 13, 1672, 12h. 10·3m. (at which epochs he found Mars to have been in the same position in regard to sidereal rotation), to be 69476d. 17h. 59·8m., and in this period, he said, Mars made 67,719 rotations: the resulting estimate of the rotation-period is 24h. 37m. 22·64s. In reality the interval was 69474d. 17h. 59·8m., and in this interval Mars made 67,717 rotations: the resulting estimate of the rotation-period is 24h. 37m. 22·71s. Again, using the observations of Hooke and Huyghens combined to give a mean, and the mean of the best observations between 1830 and 1870, we deduce the period 24h. 37m. 22·71s., which was, I find, the value I indicated as the most probable in 1873. Using observations up to those in 1884, I find for the period 24h. 37m. 22·703s. I find no noteworthy correction on using Maraldi's or W. Herschel's observations, with which, indeed, my inquiry began. I am satisfied the seconds are nearer 22·7 than 22·64.

RICHARD A. PROCTOR

A Meteor

AT 4.47 p.m. yesterday, whilst returning home with two friends, I saw a large meteor pass slowly downwards in an east-north-easterly direction. Unfortunately it was twilight and very cloudy at the time of the observation, and the "fireball," as one of my friends called it, was consequently shorn of much of its brilliancy. It was, however, distinctly visible behind a thin veil of cloud, and when seen for a couple of seconds in the open it seemed to have an apparent diameter about four times that of the planet Venus, which, with the crescent moon, were the only other conspicuous objects in the heavens at that time.

Brighton, January 10 W. AINSLIE HOLLIS

Meteorological Phenomena

I HAVE just received the inclosed notice of a meteorological phenomenon which you may consider of sufficient interest for publication in NATURE. HENRY TOYNBEE

Meteorological Office, 116, Victoria Street, London, S.W., January 6

LEAVING the port of Kingston, Jamaica, at dusk on November 23, 1885, the night was fine and starlit overhead, but about 8 p.m. a heavy bank of cloud obscured the island, and all around the upper edges of this cloud-bank brilliant flashes of light were incessantly bursting forth, sometimes tinged with prismatic hues, while intermittently would shoot vertically upwards continuous darts of light displaying prismatic colours in which the complementary tints, crimson and green, orange and blue, predominated. Sometimes these darts of light were projected but a short distance above the cloud-bank, but at others they ascended to a considerable altitude, resembling rockets more than lightning. This state of matters continued until about 9.30 p.m., when all display of light ceased. As I have never seen such a phenomenon in any other part of the world, I have deemed it an unusual occurrence, and worthy of record.

R.M.S. *Moselle*, Southampton T. MACKENZIE

I SHALL be obliged if you will allow me to record in your columns the following account of some remarkable phenomena witnessed during a voyage from Sunderland to London, and I trust that if you are good enough to insert this letter, it may be the means of eliciting some explanation from yourself or your readers as to the causes producing such strange effects. Capt. Herring, of the s.s. *Fenton*, reports to me as follows:—

"We left Sunderland at 3 p.m. on the 7th inst. bound for London, wind west-south-west, with snow squalls and strong sea; towards midnight wind increased, and the squalls cyclonic. When between Flamborough Head and Scarborough, the vessel became enveloped with phosphorescence, the mast-heads exhibiting the curious phenomenon known by sailors as 'Composants' (*corpus sancti*), which in this instance were shaped like a top, about two feet at the widest part, resembling a bunch of mistletoe illuminated. The standing rigging and all protruding objects were in like manner illuminated, and the most extraordinary effect was produced when the mate, who was on the bridge with me at the time, raised his head above the canvas weather-sheeting; the whole of his hair, exposed, and beard were instantly illuminated, and in like manner his hands when elevated became phosphorescent on the outline of his mittens. When under cover of the sheeting there was no appearance of phosphorescence; it would therefore appear that the effect of the wind produced the phenomenon. The weather towards morning moderated, and brilliant flashes of lightning were seen to the eastward." CHARLES WEST

Lloyd's, London, E.C., January 11

The Admiralty Manual on Terrestrial Magnetism

IN a recent number of NATURE you mention that the new edition of the Admiralty Manual on Terrestrial Magnetism is being edited by me. It gives me great pleasure to be able to inform those interested in this work that I have obtained the advice and assistance of Capt. Creak and Mr. Whipple as to the changes required in the description of the ship- and land-observations respectively. From the guidance of such able specialists I feel that the work will have a value that it could never have had from my unaided exertions.

GEO. FRAS. FITZGERALD

Trinity College, Dublin, January 6

Anchor Frosts

ON the night of Friday, January 8, there was an anchor frost in the Cherwell such as has not been known for twenty years, according to people who have lived at a mill on the river (Clifton Mill, near Aynho Station) for that period. In a mild form the phenomenon is fairly frequent there. The most marked effects are seen in comparatively still water.

Thus, in the mill-pond, where the current is stopped by the mill during the night, the whole stream becomes semi-viscous. Roots beneath the water, the brickwork at the sides of the mill-pond, &c., are seen to be coated with ice beneath the water as far down as can be seen, and between this ice and the surface ice-crystals form, not in a sheet or block, but interlaced loosely, like snow crystals in a drift. The mass thus formed blocks the channel, and it is said that water coming upon it from above will rise in level and flow over it, as over a solid obstruction. This I have not seen myself.

When the mill is started, at first the water will hardly flow past the wheel; but at length the crystals are forced to the surface, where they remain in floating masses, under which the water flows as usual.

The surface is not covered with a sheet of ice in these frosts.

In a broad, shallow ditch at right angles to the river, where the water is comparatively still, similar effects could be seen: the pebbles at the bottom coated with ice and the water filled with loose crystals. One consequence of the bottom ice forming on this occasion was that the floodgates were frozen down on the Friday evening, so that they could not be drawn up as usual, and the river overflowed during the night. In the morning, when they were at last raised, the water would hardly flow through, as already mentioned in the case of the water-wheel. T. HANDS

Clifton Mill, near Aynho Station

Curious Phenomenon in Cephalonia

I BEG leave to forward to you an extract from a letter which I have recently received from a friend and former pupil who is at present an officer on board one of Her Majesty's ships in the Mediterranean. I have never seen any reference to the phenomenon which he describes. If you can insert the extract, perhaps it may evoke further information with regard to it. I would not forward the statement unless I had every confidence in the writer, so that I do not think he would be likely to be easily deceived or mistaken in his observations. He is a gentleman who took an excellent position in the Cambridge Mathematical Tripos. E. LEDGER

Barham, January 7

"By the way, at Cephalonia there is a very remarkable phenomenon. The sea runs into the land in a strong stream, turning a water-wheel on the way, and disappears in the earth about a hundred yards from the entrance. Can you explain this? I believe no one has yet done so. No part of the island is below the level of the sea, nor is there any salt lake or spring in the island. I imagine this water must be converted into steam, which comes out either at Naples or Stromboli."

SIR F. J. O. EVANS

CAPTAIN SIR FREDERICK J. O. EVANS, R.N., K.C.B, F.R.S., late Hydrographer of the Admiralty, died at his residence, 21, Dawson Place, on December 20, 1885, in his seventy-first year.

This eminently scientific officer entered the Royal Navy in the year 1828, and served in H.M. ships *Rose* and *Whinchester*, on the North American station, until 1833, when he was transferred to H.M. surveying-vessel *Thunder*, Commander Richard Owen, and was employed until 1836 in surveying operations in various parts of the West Indies.

It was in this ship, and under the guidance of her able Captain, that he imbibed those scientific tastes which formed his character later in life, and laid the foundation of a career of usefulness, uninterrupted to its close, and which has perhaps rarely found a parallel in the naval profession.

Mr. Evans subsequently served in the *Caledonia*, the flag-ship in the Mediterranean, the *Asia*, the *Rapid*, the *Rolla*, the *Dido*, and *Wolverene*, of which two latter ships he was acting master. He was confirmed in that rank in 1841, and was then appointed to H.M.S. *Fly*, Capt. F. P. Blackwood, fitting for special exploring and surveying service in Australia and New Guinea, where he was continuously employed until 1846. He took a very leading part in the examination of the Coral Sea, the Barrier Reefs of Australia, Torres Strait, and the neighbouring shores of New Guinea, regions then comparatively unknown. After a short period of surveying service on the home coasts, Evans was appointed to the *Acheron*, under the late Admiral Stokes, and was engaged until 1851 in exploring and surveying the coasts of the then young colony of New Zealand; in both these important enterprises he took a very conspicuous part, and gained for himself the reputation of a skilful and scientific surveying officer, second to none in the profession.

During the Russian war Evans was employed in the Baltic on special reconnoitring service, and was attached to various ships of the fleet, taking an active part in the operations against Bomarsund and among the Aland Isles, for which he was mentioned in gazetted despatches.

It may be truly said that for many years of his life Evans was a zealous contributor to magnetic science. He had already begun to make observations of the three magnetic elements whilst employed on hydrographic work in H.M. ships *Fly* and *Acheron* in the Australian Colonies and New Zealand, between the years 1842–1851; but it was not until 1855, when he became Superintendent of the Compass Department of the Royal Navy that he was able to devote himself entirely to the magnetism of iron ships, a subject which was then growing yearly in importance, from the increasing amount of iron used in fitting as well as construction even before iron plating had brought about an actual crisis.

Sagaciously foreseeing the important part the science of magnetism was destined to play in the Navy, then being revolutionised by the change from wood to iron, he devoted his whole energies to the study of the subject until he had made himself completely master of it.

In 1865 Capt. Evans was appointed Chief Assistant to the Hydrographer, retaining his position as head of the magnetic department; this post he continued to hold until the early part of 1874, when a vacancy occurring in the Hydrographership of the Admiralty he was selected to fill it, and continued to do so with equal ability and conscientiousness until within a little more than a year of his death.

From the time of his first appointment in 1855 as Chief of the Admiralty Compass Department until his death Capt. Evans (in happy co-operation during a great part of the time with that great mathematical genius Archibald Smith) devoted himself heart and soul to the solution of what was really a question of life and death to the British Navy, and indeed to seafaring people all over the world. The question was whether it was possible so to deal with the disturbing element of iron, then entering largely into the construction of ships of all kinds, as to prevent the time-honoured compass from becoming a useless toy, or even a misleading guide. Now that the difficulty has been grappled with and conquered, we have half learned to forget the magnitude of the peril. But for the scientific and practical progress due to the labours of Capt. Evans and Archibald Smith we might almost with advantage have thrown all our compasses overboard. The attraction due partly to the inherent and partly to the induced magnetism of iron ships, and especially of plated ships, was so violent as to induce in some vessels, in certain positions, errors of two, three, or four points of compass indication. Something had been done to explain the causes of the mischief and to suggest palliatives. Famous old Flinders, at the beginning of the century, had spelt out the mystery so far as it was disclosed by the wooden ships of his time, but he had to deal with comparatively minute errors due to induction alone, and was never brought face to face with the stupendous difficulty which iron shipbuilding and iron ship-plating, afterwards created. The late Astronomer-Royal had done good and sound work in the earlier days of iron, but much more was needed to overcome the serious trouble which the newer types of mercantile and still more of naval vessels threatened to bring upon us.

It was at this critical epoch that Capt. Evans and Archibald Smith began to work together. Years of experimental labour and mathematical research went to the production of the "Admiralty Manual on Deviations of the Compass"—a book perhaps as perfect in its kind as a book could be. It is hard to do justice to the elegance of the mathematical handling, and, above all, to the happiness of the graphic methods which are found in the Manual, without seeming to indulge in extravagant laudation. An enthusiast in such matters once pronounced it a piece of lovely work, and one need not be an enthusiast to appreciate all that the epithet was meant to carry. Capt. Evans would have been the last to deny that the larger part of the purely theoretical investigation was due to his brilliant fellow-worker. Indeed his modesty often prompted him to claim less than his fair share of the credit due to both. The subject was one which called for the combination of practical sagacity and experience with refined scientific method—and if Archibald Smith was the stronger on the one side, Capt. Evans was his master on the other; nor was either of them without large powers, even in the special department of their joint labour in which he owned the supremacy of his friend. It was an undertaking which called for the united effort of just two such men as were fortunately brought together to do it, and the result has been a triumph to England and a blessing to the world which will preserve the memories of its authors as long as the ocean remains the highway of Englishmen and of the world.

The death of his old colleague did not abate the zeal of Capt. Evans, and few years passed since that time without some notable addition from the hands of the Hydrographer to our existing stock of experimental knowledge and scientific theory upon the subject which he had made his own. Much of his work will be found in the *Philosophical Transactions* of the Royal Society, and in 1870 he published an elementary manual supplementary to the Manual; both these works have been freely translated on the Continent, and are the acknowledged text-books in our own and foreign Navies to the present time.

The various steps of Evans's work may thus be stated:—

In 1858 a Chart of Curves of Equal Magnetic Declination, compiled by him for that epoch, was published by the Admiralty. This chart appeared most opportunely, for, with compass errors growing in amount and complexity, the mariner was by means of it enabled to ascertain in any part of the navigable world how far his compass deviated from the magnetic north.

In 1859 he read a paper on the magnetism of iron ships at the Royal United Service Institution. This was valuable *résumé* of all that had been hitherto done in order to obtain a knowledge of the magnetism of iron ships and the treatment of their compasses. He also communicated some results of Archibald Smith's method of analysis as applied to the errors of the compass found in H.M. ships.

Evans's next paper consisted of a Report to the Hydrographer of the Admiralty on Compass Deviations in the Royal Navy. It treated of the magnetic character of the various iron ships in the Navy, and also of the *Great Eastern* steamship. The results of this paper were (1) to show the best direction for building an iron ship; (2) the best position for placing her compass; (3) the various sources of error affecting a compass under favourable conditions. This report was communicated to the Royal Society, and published in their *Transactions* in 1860.

In 1861 he read a paper of similar import before the Institute of Naval Architects.

Reference has already been made to his work on the *Great Eastern*, and an important result of it was the experimental investigation which he was led to make as to the cause of the abnormal errors of the compasses in that vessel, proceeding from the application of Airy's system of magnet and soft-iron correctors when long single-compass needles are used.

With Evans principally as an experimentalist and Archibald Smith as the mathematician, a valuable paper on the proper length and arrangement of the needles on a compass card, together with exact information as to the proper arrangement of magnet and soft-iron correctors with respect to it, was presented to the Royal Society in 1861, being the result of the joint work of those ardent investigators into the compass question in iron ships.

Commencing with this latter paper, we find Evans and Smith as we have said above, generally working together, and under their joint editorship there appeared in 1862 the first edition of the "Admiralty Manual for Deviations of the Compass." The introduction, however, of armour-plated ships soon rendered a new edition necessary, and in 1863 it was published. This work was again revised in 1869, and became the text-book of the world on the important question of the deviations of the compass in iron ships of whatever form, being translated into all the principal European languages.

In 1865 Evans and Smith produced another important paper on the "Magnetic Character of the Armour-plated Ships of the Royal Navy," which was published in the *Phil. Trans. Roy. Soc.* The novelty of the form of ships thus discussed as regards their magnetic character caused the results to be of more than usual interest, and showed with what degree of confidence compasses might be placed in positions where both helmsman and officer might have armour protection.

The practicability of determining the magnetic coefficients without swinging, and also of ascertaining the heating error without inclining the ship, was also demonstrated, and has since been largely adopted in the Royal Navy.

In 1866 proposals were made by Mr. Evan Hopkins, C.E., to depolarise the iron hulls of ships by means of electro-magnets, and he was allowed by the Admiralty to experiment on the *Northumberland*, an armour-plated ship lying in the Victoria Docks. With the increasing difficulty of finding suitable positions for the compass, the prospect of being able to depolarise an iron ship was very attractive. In an able paper, however, read before the Royal Society in 1868, Evans showed that, so far from the hull of the *Northumberland* being depolarised, a portion of it was only temporarily, and therefore dangerously, polarised, and afterwards returned to its normal condition, thus preventing similar experiments being tried with other ships of the Navy.

It was only natural that a joint editor of the "Admiralty Manual for Deviations of the Compass," who knew the difficulties of that work for his fellow-seamen, should wish to present the subject, on which he had worked so long, in an elementary form more suitable to their every-day requirements. Evans therefore, in 1870, published his "Elementary Manual for Deviations of the Compass," a work which has been very well received by the nautical world, and has been translated into various European languages.

With the exception of some papers read at certain meetings of the British Association, and two lectures read at the Royal United Service Institution in 1865 and 1872, Evans subsequently relaxed his personal investigations into the magnetism of iron ships, and turned more to terrestrial magnetism.

Thus, in 1872, he contributed a paper to the Royal Society, on the magnetic declination in the British Islands, and compiled the magnetical instructions for the voyage of H.M.S. *Challenger*, being again assisted in this, and for the last time, by his old fellow-labourer, Archibald Smith.

Lastly, in 1878, Evans read an able and instructive lecture, on the magnetism of the earth, before the Geographical Society, showing the distribution and direction of the earth's magnetic force and the changes in its elements as then known.

Capt. Evans was elected a Fellow of the Royal Society in 1862. He sat for many years on its Council, and was more than once a Vice-President. He was also a Fellow of the Royal Astronomical and Geographical Societies; he served for many years as member of the Meteorological Committee of the Royal Society, and on the change in the constitution of that body became a member of its Council.

In recognition of his public services the Companionship of the Bath was conferred upon him in 1873, and in 1881 he was advanced to the Commandership of the same order.

Sir Frederick Evans's last public service after his retirement from the Admiralty in 1884 was as the British Delegate at the Congress of Washington for the establishment of a prime meridian and questions kindred to it.

JOHN MORRIS

PROFESSOR JOHN MORRIS died on Thursday, January 7, having been laid aside by illness for several months. Born at Homerton in 1810, he spent almost the whole of his life in or near London. For many years a pharmaceutical chemist at Kensington, he passed all his spare time in exploring the neighbourhood of the metropolis and in collecting from field and book the great store of geological knowledge which was one of his especial characteristics. But science claimed more and more of his time, and at last he abandoned business entirely. In 1855 he was appointed Professor of Geology at University College, London, which post he held till 1877, when he was succeeded by Prof. Bonney. In 1878 the honorary degree of M.A. was conferred upon him by the University of Cambridge.

Morris was elected a Fellow of the Geological Society in 1845, and, whilst in health, was a constant attendant at its meetings. He received the first Lyell Medal in 1876, and has four times received the Wollaston Donation Fund. In the Geologists' Association he has been an earnest worker, having been twice its President, and always one of the foremost leaders at its excursions.

The earliest publication by Prof. Morris was "Observations on the Strata near Woolwich," in the *Magazine of Natural History* for 1835. Most of his own descriptive papers refer to the south-east of England and in the Oolitic districts, but in association with others he has done important work elsewhere. His paper with Murchison, "On the Palæozoic and their Associated Rocks of the Thüringerwald and the Harz," read before the Geological Society in 1855, is still one of the best accounts of those districts in the English language. He was joint-author with Dr. Lycett of an important monograph for the Palæontographical Society on the Oolitic Mollusca.

Considering the enormous amount of information stored in Morris's mind, one is surprised that comparatively so little original work came from his pen, and especially that so few species of fossils except those of the Great Oolite bear his name as their author. For this, however, we may perhaps be thankful; he may have been equally well employed in reducing the number of those already in use. This he did to good purpose in his "Catalogue of British Fossils," the first edition of which was published in 1843, the second in 1854. From that date onwards he was engaged in collecting materials for a third edition, which unfortunately he did not complete. Every working geologist and palæontologist has made constant use of this book, and those who have used it most best know the vast amount of labour which its preparation entailed. It is not a mere list, compiled from various authors; but nearly every species has been critically examined and the synonymy carefully traced.

Fond of conversation, a ready and pleasing public speaker, Morris was always glad to impart his knowledge to others. This knowledge was varied and exact; minerals, rocks, and fossils were equally familiar to him, and he was well read in the wider questions of physical geology.

He was held in high regard by all who knew him; and those who gathered around his grave at Kensal Green came to pay the tribute of personal friendship not less than that of admiration for scientific worth.

DISTRIBUTION OF DRIVING-POWER IN LABORATORIES

A NOVEL arrangement has been adopted at the Physiological Laboratory at Cambridge, and at the Owens College, Manchester, for driving instruments in various rooms by means of a central motor. At the Brown Institution shafting has been used for the same purpose. This method is commonly used for driving machines which require a good deal of power, but it is not suitable for laboratories where the power is often required in many rooms, on different floors and some distance apart, thus causing great complication in the fittings. Again, when shafting is used, the instrument to be driven must be placed opposite a pulley on the shaft; in the arrangement about to be described, the instrument may be moved to any part of the tables, and the tables can be fixed in any part of the rooms.

We will now describe in detail the arrangement as applied in the Laboratory at Cambridge. The motor is an Otto gas-engine. It was found most convenient to place it in the cellar.

In Fig. 1 a pulley, B, fixed to a short length of shafting, is driven by a cord from the fly-wheel of the gas-engine, shown at A. The small pulleys at C are necessary to guide the cord in the required direction. This direction is vertical, hence no sag can compensate for changes of length due to stretching and the varying moisture of the atmosphere. The following arrangement was therefore adopted. Two grooves are turned in the pulley B, over which the cord passes twice, having between the first and second time passed under a pulley which supports a weight, W. Thus, the only effect of a change of length in the cord is to raise or lower the weight.

The short length of shafting driven in this manner by the pulley B is used to distribute the power to various rooms. A cord runs to each room, and forms a separate system, which can be stopped or started independently. This is done in the following manner. Fig. 2 shows a side view of the shafting, to which a number of pulleys are fixed. One of these, E, drives a second pulley, F, which is supported by a frame turning about a pivot, G. The pulley F has three grooves in it. A short leather band passes round the centre groove and round the pulley E; thus, if the centres of the pulleys E and F are brought together, the leather band which receives its motion from E will slip round F without driving it; but on the other hand, if the centres are pulled apart, F will be driven. When the cord H is pulled, the centres are brought together, and when released, a weight, K, gives the necessary

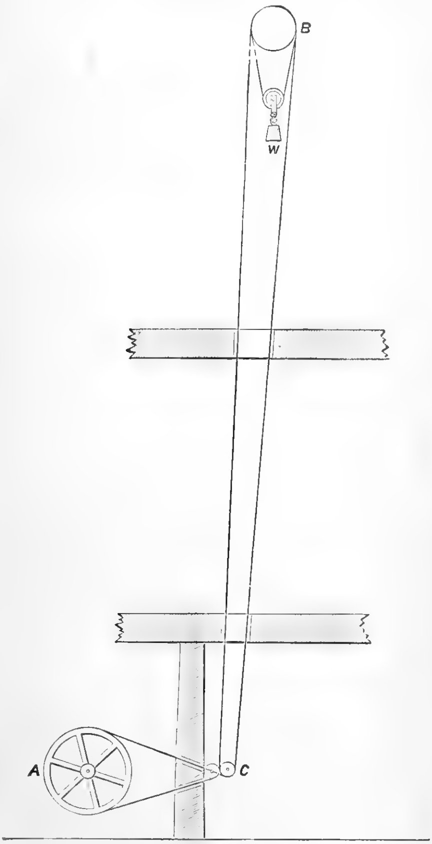


FIG. 1.

tension to the leather band. The endless cord L, which conveys power to one of the various rooms, is driven by the pulley F. This arrangement is something like that adopted for connecting the fly-wheel of the gas-engine with the shafting. The cord L first passes three-quarters of a turn round one of the grooves in the pulley F, under the pulley, M, which supports the weight K, and a quarter of a turn round the other groove of the pulley F. The cord then passes away in a horizontal direction, and is guided by pulleys round angles, either in a vertical or horizontal plane, to the rooms where the power is required. It is then guided in the same manner along the edge of each of the tables on which the instruments are to stand. The weight K, besides giving the necessary tension to the leather band, will take up all slack in the cord L. The cord runs near the ceiling, and is either led over pulleys and down to the tables in the rooms, or up through the ceiling to tables standing on the floor above.

The power is transmitted as follows to the instruments standing on the table from the cord running along its edge. Fig. 3 shows a piece of apparatus designed for this purpose, which has been called a driving-pulley. It is clamped to the edge of the table, and the cord is then made to pass round the pulley, P, as shown. This has the effect of raising the weight K, Fig. 2. The instruments are driven by a light cotton band passing round one of two grooves in a pulley fixed to the same spindle as the pulley P. The larger of the grooves is shown at Q, the smaller is not visible in the figure. The band is kept tight by means of a pulley and a weight, in the manner previously described; this arrangement also allows the

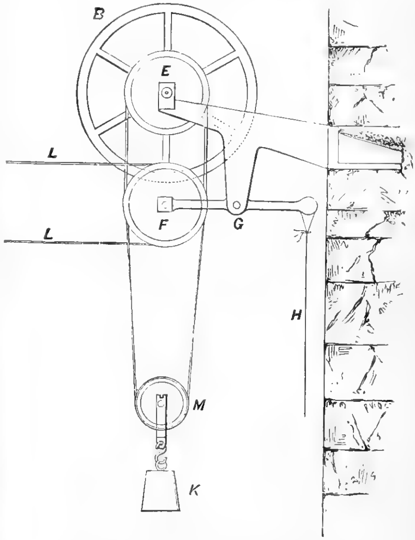


FIG. 2.

instrument to be moved to any distance from the driving pulley without altering the length of the band.

In the figure, the instrument being driven is shown at R. It is essential that it may be stopped without interfering with the cord which supplies power to the room. This is done in the following manner, which we believe is new. The handle T is fixed to a brass piece formed in the shape of a sector of a pulley, with an overhanging edge. It is arranged to turn about the bearing through which the spindle of the pulley Q passes, and can therefore rotate about the same axis as this pulley. The groove in the overhanging edge is in a line with the groove in the pulley. In the figure the cotton band is shown resting in this groove, and not in the groove of the pulley Q; now, if the sector is turned through half a revolution by the handle T, the cotton band will fall from it into the groove in the pulley Q. Thus the instrument is started; the reverse action not only throws it out of gear, but the friction of the cord running in the groove in the sector acts as a brake, and brings it quickly to rest. From the foregoing description it is evident that, once moved, the sector is required to remain in that position until moved again; in fact, it must turn with a certain amount of stiffness. A short piece of cord lies in a groove cut in its edge as shown at S; as the cord is prevented from moving and kept in tension by an india-rubber band, its friction in the groove must be overcome when the sector is turned. The smaller of the two grooves on the pulley Q is not visible in the figure, neither is the arrangement shown for lifting the cotton band out of this groove. The instrument being driven is a rotating cylinder for recording any vertical movements in the ordinary manner. Five grooves of different sizes are cut in the pulley R, and, as there are two grooves in the pulley Q, ten different speeds are possible. The sizes of these pulleys are such that the ten speeds form a geometrical series in which two consecutive speeds are in the ratio of 100 : 140.

The cotton band as well as the main driving-cord can be slipped off the driving-pulley without being cut; it can then at once be removed from the table. From this description it will be seen how the instruments may be driven, as before stated, whilst standing on any part of the table.

This method of distributing power is convenient for

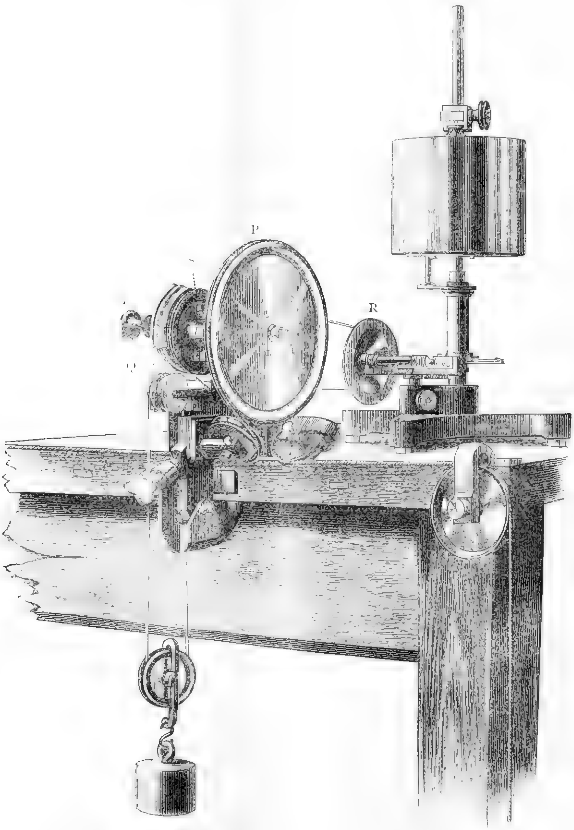


Fig. 3.

laboratories where a large amount of class-work is done, as it removes the necessity of supplying each student with a separate instrument containing clockwork. It is also most useful in original work for driving special pieces of apparatus which may often require more power than can be obtained by clockwork.

Cotton has been found to be the best material for the cords; it has the advantage of running almost silently, and is very durable. The pulleys that guide the cord from the shaft to the various rooms have been designed to run a long time without requiring oil, and with very little friction. The speed adopted is 10 feet per second; a small cord running at this speed can easily do all the work that is required.

A great variety of instruments are driven in the laboratory at Cambridge; among others we may mention a turning-lathe, also a small centrifugal machine which runs at about ninety turns per second, requiring a special driving-pulley.

The whole apparatus, both at Manchester and at Cambridge, has been designed and constructed by the Cambridge Scientific Instrument Company.

RADIANT LIGHT AND HEAT[1]

IV. (*Continued*)

Radiation and Absorption—Celestial Applications

THIS is perhaps the most suitable place for alluding to a method of obtaining a picture of the corona on ordinary occasions, recently introduced by Dr. Huggins, and which has already met with considerable success.

By using a suitable absorbing medium Huggins has been able so greatly to diminish the proportion between the terrestrial glare and the light from the corona, that a photographic image of the regions around the sun exhibits visible traces of an excess of action in certain places which are probably those occupied by the corona. Plates prepared in this manner were compared with those taken of the corona in Egypt during a total eclipse, and the comparison, made by several observers, appears to leave little doubt that the object photographed is really the corona. A development of this method would prove a great boon to solar inquiry.

Another result of the application of the spectroscope to the sun has been the determination of the rates of motion of the currents which take place in the solar atmosphere.

This is done by the method of displacement already mentioned, a motion of solar gas towards the eye pushing its spectral lines to the more refrangible side of their ordinary position, while a motion in the opposite direction has a contrary effect. In Fig. 20 we have a representation of the deviation of the F line in a spot spectrum.

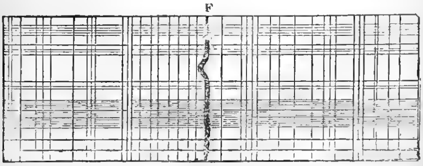


FIG. 20.

By this means prodigious solar velocities have been observed. In our earth when air moves at the rate of 100 miles an hour we count it a hurricane, but in the sun we find gaseous matter frequently moving at the rate of 100 miles a second.

It has likewise been observed that the velocities of solar motions are greatest on occasions of maximum sun spots, when there appears to be a general increase in the activity of all things belonging to our luminary.

It may therefore be said that all our observations combine in proving how extensive the solar atmosphere must be, and how enormous must be the velocities of its constituents, and more especially of the hydrogen, which enters largely into its composition.

We have thus two facts connected with our luminary which fill us with amazement. For we have, in the first place, his continued ability to radiate powerfully without cessation, or even apparent diminution, and we have, in the second, the astounding velocities of his atmospheric motions.

A little reflection will, however, serve to convince us that these two wonderful facts are intimately connected together and serve to explain each other, and that in truth the atmospheric motions are the very machinery which enables the sun to continue his radiation.

For let us inquire what is the essential condition of such continued radiation.

Clearly we must have some process by which there shall be a continuous and very rapid stream of fresh particles sent to the surface of the sun. These are there required to give out their light and heat, and then promptly to retire, being replaced by fresh particles from beneath, which again in their turn give out light and heat and then rapidly retire. It is necessary that there should be some powerful machinery of this kind, in virtue of which fresh recruits shall continually be carried to the front, while the exhausted battalions are promptly marched behind into the magazine.

Now such machinery is supplied in the vast and intense solar convection currents by means of which the cold matter from above is rapidly carried down, forming a sun spot, while the hot matter from beneath is rapidly carried upwards, forming a facula.

This ceaseless system of ascending and descending currents gives rise, no doubt, to the mottled appearance of our luminary, while in certain districts of the sun and on certain occasions the system is swelled out into gigantic proportions, and we have a large sun spot, with its accompanying faculæ. Nor is it difficult to understand why convection currents should be so powerful in the atmosphere of our luminary. The intensity of such currents will depend upon the following conditions:—

(1) On the intensity of the heat of the hot portions of the arrangement as compared to that of the cold.

(2) On the intensity of gravity.

(3) On the scale of the whole arrangement.

(4) On the presence of condensible substances in the atmosphere.

Now in the sun the heat of the hot particles is very great, while the space around the sun may be taken to represent something without heat. Again the intensity of gravity at the sun's surface is very great, being about twenty-eight times greater than that with which we are familiar on the earth.

In the third place, the scale of the whole arrangement is very great; and, lastly, we have without doubt the presence of condensible substances in the solar atmosphere. All these are powerful causes, and we must bear in mind that they have not merely to be added, but rather multiplied together. Can we therefore wonder that their joint effect is such as to raise the violence of solar storms into something like 60 or 100 miles per second?

These considerations may likewise, perhaps, serve to throw light on the question of solar variability. We have seen that sun spots have a period of eleven years, and that near the minimum of this period there are occasions when the sun is entirely without spots.

Now it is sufficiently obvious, and has likewise been proved experimentally, that a sun spot gives out less light and heat than the ordinary solar surface. On the other hand, the proportion which the spotted area bears to that of the whole disc is insignificant, so that, taking these two facts together, we should at first sight imagine that the sun ought to give us very slightly less light and heat on those occasions when there are most spots.

I think, however, that this direct action is probably inappreciable, and that sun spots are rather to be regarded as *symptoms* of a particular state of the sun, implying an increased activity of solar convection currents. Now, inasmuch as the outpouring of solar light and heat is kept up by means of these convection currents, we might therefore expect that on occasions when such currents are peculiarly powerful the sun should give out most light and heat. To use the words of the late Sir J. Herschel, the "*sun pot*" may on such occasions be boiling very rapidly.

On the whole, therefore, theory would lead us to infer that the sun will be found most powerful in its radiation on those occasions when it has most spots on its surface. It will, however, be noticed that this is merely a theoretical conclusion, and has to be supported by evidence which must of course be terrestrial. Have we, then, any terrestrial evidence that the sun is more powerful in its

[1] Continued from p. 38.

radiation at times of maximum than at times of minimum sun spot frequency?

In reply to this question, we must acknowledge that of direct evidence derived from the actinometer we have hardly any. Certain preliminary observations made by Mr. Hennessey at the headquarters of the Trigonometrical Survey in India may perhaps induce us to imagine that the sun may be most powerful on occasions of maximum sun spot frequency, but this is far from conclusive. We have, however, very strong indirect evidence in favour of this conclusion. This is derived partly from the facts of terrestrial magnetism and partly from those of terrestrial meteorology, that from the former being the stronger of the two. It is well known that the sun produces changes in the magnetism of the earth. It gives rise, for instance, to the solar-diurnal variation of the needle which is a systematic change; and it likewise produces magnetic storms, these words being employed to denote changes of a peculiarly abrupt and irregular kind. Now undoubtedly these both imply an energetic action of some kind on the part of the sun, and we have strong grounds for supposing that this energetic action is connected with the radiating power of our luminary. But both of these solar actions upon the magnetism of the earth are decidedly stronger in times of maximum than in times of minimum sun spot frequency.

Such electrical phenomena as the aurora borealis and the currents which take place in the crust of the earth are likewise peculiarly developed on the same occasions.

In Fig. 21 we have a diagram representing the connection between sun spot maxima, the maxima of declination range, and the frequency of the aurora borealis.

When we come to meteorology, the evidence before us is not so conclusive, although here also what we have tends, I think, in the same direction. Mr. Meldrum has shown that there are most cyclones in the Indian Ocean

SOLAR SPOTS, MAGNETIC DECLINATION, AND AURORAL DISPLAYS.

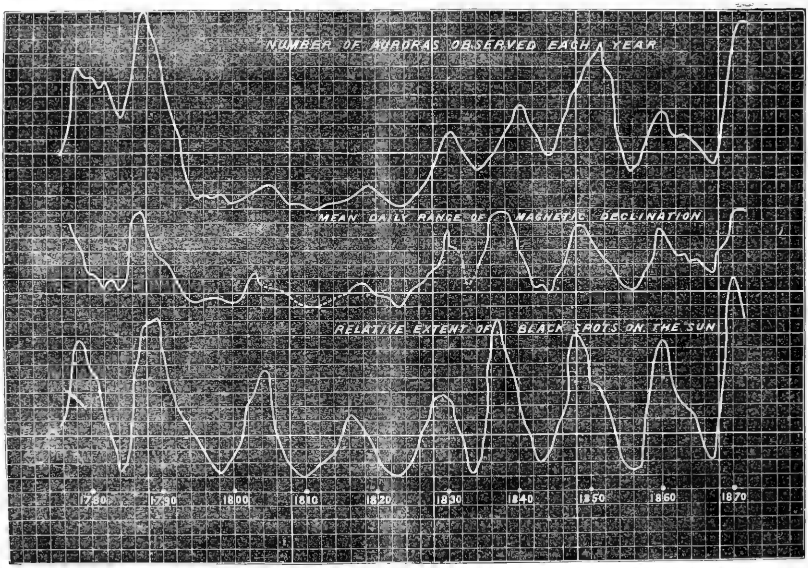


FIG. 21.

about times of maximum sun spots, and M. Pöey has proved the same thing with respect to West Indian hurricanes. On the whole, too, and in the majority of stations, the rainfall is greatest on the same occasions.

Again, let us take the barometric pressure of the air. Here a little reflection will convince us that the peculiar variations in the distribution of such pressure are really caused by the sun. For instance, we know that Western Siberia during the winter season has a pressure decidedly above the average, and we should therefore imagine that in years when the sun is peculiarly powerful the winter pressure in Siberia would prove to be particularly high. Now this is just the state of things which Mr. Blanford has found to correspond with years of maximum sun spot frequency, and thus the evidence is in favour of these being also years of maximum solar power. The Indian meteorologists have derived similar conclusions from the observations made in India. In fine, we may, with the balance of probability in our favour, adopt the conclusion deduced by Mr. Baxendell at a comparatively early period, who found that the forces which produce the movements of the atmosphere were apparently more energetic in years near maximum than in years near minimum sun spot frequency.

Let me now proceed to indicate the nature of the information which the spectroscope gives us regarding the planets and comets of our system. Since the moon and the various planets are illuminated by the sun, their spectra will necessarily be built upon that of the sun. As a matter of fact, this is found to be the case; but we ought to bear in mind that the solar rays that reach us from a planet must have penetrated some distance into the atmosphere of that planet. In doing so they will most probably have suffered spectral absorption, the nature of which may thus suffice to throw light upon the constitution of the planet's atmosphere.

Working in this manner, Dr. Huggins has observed no trace of an atmosphere in the moon, but in the spectrum of Jupiter lines are seen which indicate the existence of an absorbing atmosphere. One band appears to correspond in spectral position with dark lines due to our earth's atmosphere; but another band is different from

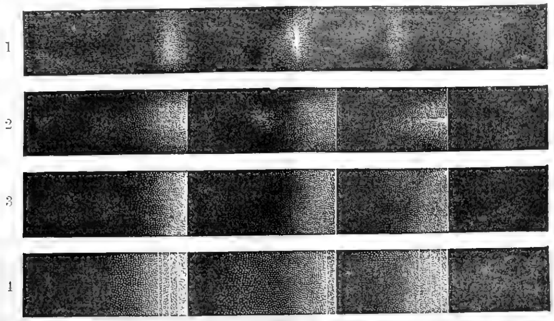


Fig. 22.—(1) Spectrum of Brorsen's comet; (2) Spectrum of Winnecke's comet; (3) Spectrum of carbon in olefiant gas; (4) Spectrum of carbon in olive oil (Huggins).

any line caused by our atmosphere, and indicates most probably the existence of some unknown constituent. Saturn has likewise a band common to the earth, so that aqueous vapour probably exists in the atmospheres of Jupiter and Saturn.

The spectrum of Mars indicates in like manner the

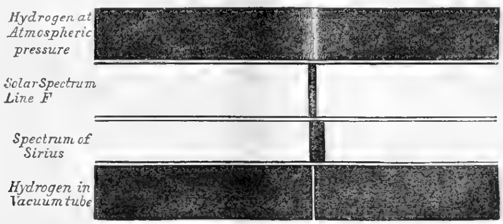


Fig. 23.

existence in the atmosphere of that planet of matter similar to that which occurs in the earth's atmosphere.

The absorption spectra of the far distant planets have likewise been examined.

Padre Secchi and M. Janssen agree with the conclusion that the vapour of water probably exists in certain planetary atmospheres.

In the absorption spectrum of our atmosphere Professor

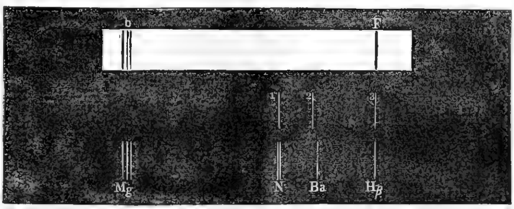


Fig. 24.—First, the solar spectrum; next, the spectrum of the nebulæ; 1, 2, 3 the lines observed. Below, the bright lines of magnesium, nitrogen, barium, and hydrogen.

Piazzi-Smyth[2] has noticed a band which appears to be associated with the presence or possibility of rain, and which he has termed the rain-band. Strangely enough in the bright spectrum of the aurora borealis, which comes from our atmosphere, there is a line which we cannot identify with the spectrum of any known terrestrial substance.

Dr. Huggins has likewise studied the spectra given by the brighter portions of comets, and has obtained for many of these bodies lines which resemble the spectrum of carbon, as taken in a hydrocarbon.

In Fig. 22 we have, first, the spectrum of Brorsen's comet; secondly, the spectrum of Winnecke's comet; thirdly, the spectrum of carbon in olefiant gas; fourthly, that of carbon in olive oil.

More recently the same observer has found other specimens of this class of bodies, which give spectra essentially different from the hydrocarbon type, and he remarks that as the meteors which come down to us differ greatly in chemical constitution, so it is not surprising that a similar difference should be found in comets which we know to be very closely allied to meteors.

Dr. Miller and Mr. Huggins were amongst the first to give us information regarding the spectra of stars. These bodies exhibit spectra very similar to that of the sun—that is to say, they give us an underlying continuous spectrum, intersected with dark lines. We have thus evidence of a similarity in physical constitution between our sun and these very distant bodies.

The position of the dark lines is the great object of interest in stellar spectra, and by the method already described the presence of various terrestrial elements has been detected in the stars.

In the most brilliant bluish-white stars, along with the presence of numerous fine lines, we have a comparatively small number of prominent absorption lines, the substances which these indicate as present being hydrogen, calcium, magnesium, and sodium. We shall return to this subject on a future occasion.

Miller and Huggins were so fortunate as to obtain the spectrum of a star which suddenly blazed out in May, 1866, and found in it the unmistakeable presence of bright hydrogen lines.

Such a star is probably to be regarded as exhibiting on an enormous scale the same phenomenon which is frequently seen in the outburst of hydrogen from the interior of our luminary. Indeed, we have sometimes bright lines of hydrogen in the spectrum of certain solar regions. Padre Secchi has also ascertained that several very small stars exhibit bright lines.

I need hardly say that in the case of the fixed stars where the disc is a mere point, we have no possibility of differentiating between various portions of it, or of ascertaining the velocities of its atmospheric motions by spectral displacement.

We have, however, the means of ascertaining by this method whether the star be approaching us or receding from us, and how rapidly it is doing so. Huggins has made many laborious and interesting observations of this nature, and has determined the relative motion to or from us of many stars—a result which could not possibly be ascertained without the spectroscope.

In Fig. 23 we have an indication of the proper motion of Sirius as seen by the displacement of the hydrogen line F in the spectrum of that star.

Before concluding this branch of my subject, let me briefly allude to the light thrown by spectrum analysis on the composition of certain of the nebulæ. On directing his stellar spectroscope to the planetary nebula in the constellation Draco on 20th August, 1864, Dr. Huggins found that its spectrum consisted of three bright lines on a dark background—in fine, that it was the spectrum of incandescent gas.

Of these three lines one is in all probability the hydrogen line H; another appears to coincide with one of the lines of nitrogen, while the third does not coincide with any known line.

Other nebulæ have since been found by Huggins to give us similar spectra.

Fig. 24 denotes the general spectrum given by the nebulæ.

It thus appears that we have already derived great information regarding the constitution of the heavenly bodies by means of spectrum analysis.

BALFOUR STEWART

(*To be continued.*)

NOTES

THE death is announced, in his seventy-first year, of Dr. John Christopher Draper, Professor of Chemistry in the Medica Department of the University of the City of New York. Dr. Draper was the eldest son of the eminent Prof. John W. Draper. His scientific papers, apart from those on the science of medicine, are devoted to chemical and physical subjects; and among the latter chiefly to optical phenomena. His last one, relating to dark lines in the solar spectrum, attracted some attention at the time, 1878-79.

THE death is announced of Mr. James Fergusson, F.R.S., on the 9th inst., at the age of seventy-eight years. Mr. Fergusson was well known by his writings on Indian architecture, and also by his magnificent work on "Tree and Serpent Worship in India."

THE deaths among French Academicians have been unusually numerous of late; we have to record this week that of M. de Saint-Venant, a member of the Section of Geometry.

THE Russian Academy of Science has elected Mr. David Gill, Astronomer-Royal at the Cape of Good Hope, a Corresponding Member.

SEVERAL French papers have published articles on the opportunity of celebrating the centenary of Arago's birth, this celebrated astronomer and physicist having been born at Estagel, a country town of the Department of the Pyrénées Orientales, on Feb. 26, 1786. As he was a Copley Medallist and a foreign member of the Royal Society of London, it is expected that this Society will be invited to send a delegate to take part in the proceedings. Arago was elected a member of the Paris Academy at the early age of twenty-three, after having achieved the measurement of the meridian arc from Dunkirk to Formentera, for determining the length of the metre. His predecessor was Jerome de Lalande. In 1830 he was elected Perpetual Secretary, and he continued to act as such during twenty-three years up to his death, which took place in 1853. His works have been edited by Barral, and fill seventeen large octavo volumes, of which four are devoted to "Astronomie Populaire."

IN a very excellent article in *Science* on "The Government and its Scientific Bureaus," we find some wholesome remarks on the conditions under which scientific work can be performed at its best. "Science cannot be carried forward by prescribing too definitely the tasks of scientific men. They may be bound by appointed days and hours; they may be told to perform specific duties,—and if only the maintenance of routine work is required, such regulations may secure fidelity and efficiency. But if knowledge is to be advanced, if better methods of work are to be discovered, if greater accuracy is desired, if unknown facts are to be ascertained and recorded and discussed, and, in short, if there is to be real progress, the methods of freedom are to be employed, not those of petty regulation. By this we mean that if the great undertakings which the Government has in charge, if especially its surveys of the coast and of the interior are to go forward, discretion must be given to the chiefs of bureaus, and they must be held to accountability for the aggregate success of their work. Honesty, economy, clear and accurate statement of accounts are, of course, to be demanded in every office: nobody questions this. But the determination of what shall be undertaken in a given year, to whom it shall be assigned, what allowances shall be made for instruments, books, and assistants, —these are questions which experience and judgment must decide. Somebody who has all the facts in mind must make the determination, and he must not be too quickly condemned, because the immediate results of the investigations which he has undertaken are not yet apparent. The highest personal character should be found in every one who is called upon to direct the labours of a scientific corps; he should be faithful, watchful, careful that all the interests intrusted to him may be promoted; but he should be free within the limitations of his office to select his subordinates, determine their duties, and prescribe their methods. Only by such regulated freedom as this can the highest results be obtained. Discretion with responsibility, in all the higher work of science, will bring the best services from those whose moral attitude is what it should be: no others should be intrusted with the leadership."

FROM the "Washington Letter" of *Science* we learn that in the retiring address of the President of the Chemical Society there Prof. F. W. Clarke gave "an able and entertaining *résumé* of the growth of chemistry in Washington during the past twelve or fifteen years." The President concluded with a plea for the establishment of a national laboratory, which, in its dimensions and equipment, should be commensurate with the importance and dignity of the science. Arguments to show the economy in, and the necessity for, such an establishment were not lacking, either in number or force. Examples of duplication or useless repetition of work, multiplication of instruments and facilities with no increase in efficiency, and frittering away time and energy on work properly belonging elsewhere, were given with a convincing emphasis, which made it a little difficult, at the close of the address, to believe that there were two sides to the question.

THE programme of the Congress of French Learned Societies for 1886 has been declared by a decree published by the Minister of Public Instruction. Amongst other subjects to be discussed by the fifth, or Natural Sciences Section, we find the following:—Study of the topographical distribution of the species inhabiting the French coasts; detailed study of the fluviatile fauna of France, indicating the species which are migratory and those which are permanent, and in the former case the dates of arrival and departure, noting also the time of laying the eggs, and the influence of the composition of the water; study of the migrations of birds, and of the periodical phenomena of vegetation, noting the coincidences of budding, flower, and maturity, with the appearance of the principal kinds of insects injurious to agriculture; the influence of winter temperatures on insects and their duration; study of honey- and wax-producing insects; a study, from an anthropological point of view, of the different populations which have occupied, in whole or part, a certain part of France since the most remote times; the course and duration of the great epidemics of the Middle Ages and of recent times; a comparison between the Tertiary vertebrates of the various French formations in view of the successive modifications which the types have undergone; a comparison of the Quaternary vertebrates with similar species of the present epoch; a comparison of the flora of the southern departments of France with that of Algiers; the Eucalyptus and its uses; the influence of the chain of the Cevennes in the propagation northwards of the Mediterranean species of plants and animals; a study of the general movements of sand in Asia and Africa, noting the region in which it is retreating and that in which it is advancing.

WE lately commented on a suggestion made, on economical grounds, that Jamaica should diminish the amount spent on, and by consequence the usefulness of, the Colonial Botanic Gardens. We are pleased to notice that similar views do not prevail elsewhere in the West Indian Islands, for at a late meeting of the Legislative Council of Grenada, the Governor announced that it had been decided to establish a Botanic Garden on the island. The site, he said, was selected on Government land, and an annual grant of 300*l.* was placed on the estimates for the expense of preparing the ground and paying a superintendent, who has not yet been engaged. The sum appears small, but is really a considerable amount for an island which is small and far from wealthy.

MESSRS. WODDERSPOON AND CO., Serle Street, Lincoln's Inn, are publishing in one sheet on paper for sixpence, an easy guide to the principal constellations and stars visible in Great Britain. We have first a map of the circumpolar stars, and another showing those north and south of the equator; the guiding lines, by which the stars can be easily found from the instructions carefully given, being printed in red ink. It is very clear that the author has embodied in this cheap chart the results of much labour for the teaching of people uninstructed in such matters. We learn, indeed, that many copies have already been given away among coastguardsmen, labourers, and others, who, after a little instruction, use them greedily, and delight in having them to refer to. This is distinctly a good work, and we trust that some of our readers will follow it up.

WE hear that the reconstruction of the Naval Astronomical Observatory of Japan, which has been deferred for several years owing to the extraordinary outlay required, is to be commenced at once according to the plans originally prepared.

IT is stated that M. Paul Bert, the French physiologist, has been appointed Resident in Annam, Tonquin, and Cambodia.

A COMPLETE set of observations of the new star in Orion discovered by Mr. J. E. Gore on December 13, 1885, was, *Science* states, obtained at Harvard College Observatory on December 16—the very evening on which the despatch was received from Lord Crawford—settling the non-identity of the star with D.M. + 20°, 1172, the star named in the despatch. A meridian circle observation by Prof. Rogers gave for the position of the *nova* R.A. 5h. 49m. 4·25s., Decl. + 20° 9′ 15″·6. Prof. Pickering's photometric measures made the magnitude 6·2, and the spectroscope showed the existence of bright bands. Two excellent photographs fixing the position of the star with reference to neighbouring stars were obtained, and one photograph of the spectrum. The indications are suggestive of the new star being a long-period variable, and there was a slight suspicion of a diminution in magnitude during the first six or seven hours it was under observation.

MR. WOOD-MASON has, it is stated, undertaken to prosecute a thorough inquiry into the silk-producing larvæ of India.

SOUTH-EASTERN ROUMELIA was visited on the evening of the 8th and morning of the 9th inst. by earthquake shocks, some of which were of a violent character. At Philippopolis the movement is described as being in a south-south-easterly direction.

ON December 29, 1885, there was an earthquake at Ismidt, in Asia Minor, not far from Constantinople. It took place at half-past one in the afternoon. The oscillations were slight, and passed from west to east.

AN interesting discovery of bronze hatchets and other prehistoric warlike instruments has been made at Llanwitt Major, Glamorganshire. As a number of workmen were engaged in digging a foundation for a building, they discovered three spear-heads, six hatchet-like celts, and several other interesting relics, which were concealed under an ancient wall. Some bones were also found. A further search is being organised.

SOME interest is being excited among geologists in Kent by the great depth to which a boring has been sunk at the Dover Guard Prison for a water supply. The boring, which is close to the sea, has now reached a depth of 1000 feet, being 700 feet below the sea-level.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. T. Risely Griffith; a Gray Ichneumon (*Herpestes griseus*) from India, presented by Capt. J. Cutting; a Gray Squirrel (*Sciurus cinereus*) from North America, presented by Mrs. Charles Neck; a Golden Eagle (*Aquila chrysaetos*), European, presented by Mr. H. V. Knox; a Bronze-winged Pigeon (*Phaps chalcoptera*) from Australia, presented by Mr. Augustus F. Spry; a —— Hangnest (*Xanthosomus icterocephalus*) from Venezuela, a Song Thrush (*Turdus musicus*), British, deposited; a White-thighed Colobus (*Colobus vellerosus*), a Moustache Monkey (*Cercopithecus cephus*), a Ludio Monkey (*Cercopithecus ludio*) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

THE LEYDEN OBSERVATORY.—Prof. H. G. van de Sande Bakhuyzen has published his Report for the year ending September 15, 1885. The work to which the meridian circle was devoted during the year was the continuation of the observation of a selected list of fairly bright stars situated in the immediate neighbourhood of the Pole. It is expected that this series of observations will be finished off during the present winter. With the 7-inch refractor, nine observations of Wolf's comet were made. Between October 1884 and March 1885, a series of measures have been made with Airy's double-image micrometer attached to this equatorial, for the purpose of determining the systematic errors of the measures of the diameters of Mars and Uranus obtained in former years. For this purpose, Prof. Bakhuyzen has measured the diameters of artificial disks, formed by circular holes in a copper plate, made so as to resemble, both in size and brightness, the planets themselves. The results of these investigations will be published shortly. The reduction of the meridian observations, 1877-85, is in a forward state, some parts being nearly completed. This work is intrusted to Dr. E. F. van de Sande Bakhuyzen, the First Observer. Some progress has also been made in the reduction of the zone observations, 1874-76. Prof. Bakhuyzen himself has been chiefly occupied with his monograph on the rotation-period of Mars, now published. In March 1885 work was commenced in connection with the erection of the new $10\frac{1}{2}$-inch objective, and the instrument is now ready for use. The mounting has been supplied by the Repsolds, and the object-glass by Alvan Clark and Sons. Its performance, so far as it has yet been tested, appears to be remarkably good, and does not compare unfavourably with that of other instruments of similar size. In Prof. Bakhuyzens' hands it will doubtless do good work.

FABRY'S COMET.—Dr. H. Oppenheim gives the following ephemeris for this comet for Berlin midnight:—

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Log *r*
Jan. 17	23 31 4	+21 53·4	0·2304	0·2025
19	23 29 58	22 5·3		
21	23 28 58	22 18·2	0·2316	0·1857
23	23 28 3	22 32·1		
25	23 27 14	22 46·9	0·2319	0·1682

BROOKS'S COMET.—The following elements and ephemeris have been computed for this comet by Dr. J. Palisa:—

$$T = 1885 \text{ Nov. } 28{\cdot}2436 \text{ Berlin M.T.}$$

$$\left.\begin{aligned} \pi &= 301°\ 29'\ 50'' \\ \Omega &= 262\ 30\ 48 \\ i &= 42\ 31\ 27 \end{aligned}\right\} \text{Mean Eq. } 1886{\cdot}0.$$

$$\log q = 0{\cdot}04091$$

Error of the middle place (O – C).

$$d\lambda \cos\beta = +4''{\cdot}7 \qquad d\beta = 4''{\cdot}5$$

Ephemeris for Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log. Δ	Log. *r*	Brightness.
Jan. 14	21 5 25	+12 8·6	0·2921	0·1261	0·74
18	21 20 46	13 48·6	0·2989	0·1377	0·68
22	21 35 48	15 25·2	0·3064	0·1495	0·62
26	21 50 48	+16 57·4	0·3146	0·1614	0·57

The brightness on December 28 is taken as unity.

BARNARD'S COMET.—For Barnard's comet Dr. H. Oppenheim gives the following ephemeris, also for Berlin midnight:—

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Log *r*
Jan. 17	2 37 45	+11 14·7	0·2136	0·3193
19	2 34 22	11 38·4		
21	2 31 8	12 2·5	0·2173	0·3068
23	2 28 4	12 27·0		
25	2 25 9	12 51·8	0·2213	0·2937

GORE'S NOVA ORIONIS.—Dr. Copeland, examining the spectrum of this object at Lord Crawford's Observatory, Dun Echt, finds distinct evidence of a spectrum of bright bands superposed on a well-marked spectrum of the third type; these bright bands corresponding to those ordinarily seen in cometary spectra, and obtained in the spectrum of a coal-gas flame.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 17–23

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 17

Sun rises, 8h. 0m.; souths, 12h. 10m. 24·5s.; sets, 16h. 21m.; decl. on meridian, 20° 42′ S.: Sidereal Time at Sunset, 0h. 9m.

Moon (Full on January 20) rises, 13h. 53m.; souths, 21h. 44m.; sets, 5h. 39m.*; decl. on meridian, 18° 13′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 40	10 36	14 32	22 59 S.
Venus	9 12	14 39	20 6	7 14 S.
Mars	21 30*	4 0	10 30	5 9 N.
Jupiter	22 39*	4 38	10 37	1 6 S.
Saturn	14 15	22 25	6 35*	22 36 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
17	117 Tauri	6	15 38	16 28	33 264
18	130 Tauri	6	0 54	1 59	124 310
18	26 Geminorum	$5\frac{1}{2}$	20 37	21 44	43 271
20	1 Cancri	6	2 3	2 49	61 338
22	37 Sextantis	6	19 16	20 7	33 224

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.
U Cephei	0 52·2	81 16 N.	Jan. 18,	0 2 *m*
			,, 22,	23 41 *m*
Algol	3 0·8	40 31 N.	,, 19,	20 0 *m*
ζ Geminorum	6 57·4	20 44 N.	,, 18,	5 0 *m*
			,, 23,	7 30 *M*
S Cancri	8 37·4	19 27 N.	,, 19,	3 23 *m*
δ Libræ	14 54·9	8 4 S.	,, 19,	17 20 *m*
			,, 22,	1 11 *m*
U Coronæ	15 13·6	32 4 N.	,, 19,	23 6 *m*
U Ophiuchi	17 10·8	1 20 N.	,, 17,	18 41 *m*
			and at intervals of	20 8
β Lyræ	18 45·9	30 14 N.	Jan. 19,	19 0 *m*
η Aquilæ	19 46·7	0 43 N.	,, 17,	0 0 *m*
δ Cephei	22 24·9	57 50 N.	,, 19,	0 0 *M*
			,, 22,	19 0 *m*

M signifies maximum; *m* minimum.

MR. AITKEN ON DEW[1]

THE first point referred to in this paper is the source of the vapour that condenses to form dew. A short historical sketch is given of the successive theories from time to time advanced on this point, showing how in early times dew was supposed to descend from the heavens, and then afterwards it was suggested that it rose from the earth, while Dr. Wells, who has justly been considered the great master of this

[1] Abstract of Paper read before the Royal Society of Edinburgh on December 21, 1885, communicated by permission of the Council of the Society.

subject, thought it came neither from above nor from below, but was condensed out of the air near the surface of the earth. He combated Gersten's idea that it rose from the earth, and showed that all the phenomena observed by Gersten and others which were advanced to support this theory could be equally well explained according to the theory that it was simply formed from the vapour present at the time in the air, and which had risen from the ground during the day, and concluded that if any did rise from the ground during night, the quantity must be small, but, with great caution, he adds that "he was not acquainted with any means of determining the proportion of this part to the whole."

A few observations of the temperature of the ground near the surface and of the air over it, first raised doubts as to the correctness of the now generally-received opinion that dew is formed of vapour existing at the time in the air. These observations, made at night, showed the ground at a short distance below the surface to be always hotter than the air over it; and it was thought that so long as this excess is sufficient to keep the temperature of the surface of the ground above the dew-point of the air, it will, if moist, give off vapour; and it will be this rising vapour that will condense on the grass and form dew, and not the vapour that was previously present in the air.

The first question to be determined was whether vapour does, or does not, rise from the ground on dewy nights. One method tried of testing this point was by placing over the grass, in an inverted position, shallow trays made of thin metal and painted. These trays were put over the ground to be tested after sunset and examined at night, and also next morning. It was expected that, if vapour was rising from the ground during dewy nights, it would be trapped inside the trays. The result in all the experiments was that the inside was dewed every night, and the grass inside was wetter than that outside. On some nights there was no dew outside the trays, and on all nights the inside deposit was heavier than the outside one.

An analysis of the action of these trays is given, and it is concluded that they act very much the same as if the air was quite still. Under these conditions vapour will rise from the ground so long as the vapour-tension on the surface of the ground is higher than that at the top of the grass, and much of this rising vapour is, under ordinary conditions, carried away by the passing air, and mixed with a large amount of dryer air, whereas the vapour rising under the trays is not so diluted; and hence, though only cooled to the same amount as the air outside, it yields a heavier deposit of dew.

Another method of testing this point was employed, which consisted in weighing a small area of the exposed surface of the ground, as it was evident that if the soil gave off vapour during a dewy night, it must lose weight. A small turf about 6 inches (152 mm.) square, was cut out of the lawn and placed in a small shallow pan of about the same size. The pan with its turf, after being carefully weighed, was put out on the lawn in the place where the turf had been cut. It was exposed for some hours while dew was forming, and on these occasions it was always found to lose weight. It was thus evident that vapour was rising from the ground while dew was forming, and therefore the dew found on the grass was formed of part of the rising vapour, trapped or held back by coming into contact with the cold blades of grass.

The difference between these experiments in which the exposed bodies *lose* weight, and the well-known ones in which bodies are exposed to radiation, and the amount of dew formed is estimated by the *increase* in their weight, is pointed out. In the former case the bodies are in good heat-communication with the ground, whereas in the latter, little or no heat is received by conduction from the earth.

Another method employed for determining whether the conditions found in nature were favourable for dew rising from the ground on dewy nights, was by observations of the temperatures indicated by two thermometers, one placed on the surface of the grass, and the other under the surface, amongst the stems, but on the top of the soil. The difference in the readings of these two thermometers on dewy nights was found to be very considerable. From 10° to 18° F. was frequently observed. A minimum thermometer placed on, and another under, the grass, showed that during the whole night a considerable difference was always maintained. As a result of this difference of temperature, it is evident that vapour will rise from the hotter soil underneath, into the colder air above, and some of it will be trapped by coming into contact with the cold grass.

While the experiments were being conducted on grass land, parallel observations were made on bare soil. Over soil the inverted traps collected more dew inside them than those over grass. A small area of soil was spread over a shallow pan, and after being weighed was exposed at the place where the soil had been taken out, to see if bare soil as well as grass lost weight during dewy nights. The result was that on all nights on which the tests were made the soil lost weight, and lost very nearly the same amount as the grass land.

Another method employed of testing whether vapour is rising from bare soil, or is being condensed upon it, consisted in placing on the soil, and in good contact with it, small pieces of black mirror, or any substance having a surface that shows dewing easily. In this way a small area of the surface of the earth is converted into a hygroscope, and these test-surfaces tell us whether the ground is cooled to the dew-point or not. So long as they remain clear and undewed, the surface of the soil is hotter than the dew-point, and vapour is being given off, while if they get dewed, the soil will also be condensing vapour. On all nights observed, these test-surfaces kept clear, and showed the soil to be always giving off vapour.

All these different methods of testing point to the conclusion that during dewy nights, in this climate, vapour is constantly being given off from grass-land, and almost always from bare soil; that the tide of vapour almost always sets outwards from the earth, and but rarely ebbs, save after being condensed to cloud and rain, or on those rarer occasions on which, after the earth has got greatly cooled, a warm moist air blows over it. The results of some of the experiments are given, showing, from weighings, the amount of vapour lost by the soil at night, and also the heat lost by the surface soil.

It seems probable that when the radiation is strong, that soil, especially if it is loose and not in good heat-communication with the ground, will get cooled below the dew-point, and have vapour condensed upon it. On some occasions the soil certainly got wetter on the surface, but the question still remains, Whence the vapour? Came it from the air, or from the soil underneath? The latter seems the more probable source: the vapour rising from the hot soil underneath will be trapped by the cold surface-soil, in the same way as it is trapped by grass over grass-land. During frost, opportunities are afforded of studying this point in a satisfactory manner, as the trapped vapour keeps its place where it is condensed. On these occasions the under sides of the clods, at the surface of the soil, are found to be thickly covered with hoar-frost, while there is little on their upper or exposed surfaces, showing that the vapour condensed on the surface-soil has come from below.

The next division of the subject is on dew on roads. It is generally said that dew forms copiously on grass, while none is deposited on roads, because grass is a good radiator and cools quicker, and cools more, than the surface of a road. It is shown that the above statement is wrong, and that dew really does form abundantly on roads, and that the reason it has not been observed is that it has not been sought for at the correct place. We are not entitled to expect to find dew on the surface of roads as on the surface of grass, because stones are good conductors of heat, and, the vapour-tension being higher underneath than above the stones, the result is, the rising vapour gets condensed on the under sides of the stones. If a road is examined on a dewy night, and the gravel turned up, the under sides of the stones are found to be dripping wet.

Another reason why no dew forms on the surface of roads is that the stones, being fair conductors, and in heat-communication with the ground, the temperature of the surface of the road is, from observations taken on several occasions, higher than that of the surface of the grass alongside. The air in contact with the stones is, therefore, not cooled so much as that in contact with the grass.

For studying the formation of dew on roads, slates were found to be useful. One slate was placed over a gravelly part of the road, and another over a hard dry part. Examined on dewy nights the under sides of these slates were always found to be dripping wet, while their upper surfaces, and the ground all round, were quite dry.

The importance of the heat communicated from the ground is illustrated by a simple experiment with two slates or two iron weights, one of them being placed on the ground, either on grass or on bare soil, and the other elevated a few inches above the surface. The one resting on the ground, and in heat-communication with it, is found always to keep dry on dewy nights, whereas the elevated one gets dewed all over.

The effect of wind in preventing the formation of dew is referred to. It is shown that, in addition to the other ways already known, wind hinders the formation of dew by preventing an accumulation of moist air near the surface of the ground.

An examination of the different forms of vegetation was made on dewy nights. It was soon evident that something else than radiation and condensation was at work to produce the varied appearances then seen on plants. Some kinds of plants were found to be wet, while others of a different kind, and growing close to them, were dry, and even on the same plant some branches were wet, whilst others were dry. The examination of the leaf of a broccoli plant showed better than any other that the wetting was not what we might expect if it were dew. The surface of the leaf was not wet all over, and the amount of deposit on any part had no relation to its exposure to radiation, or access to moist air; but the moisture was collected in little drops, placed at short distances apart, along the very edge of the leaf. Closer examination showed that the position of these drops had a close relation to the structure of the leaf; they were all placed at the points where the veins in the leaf came to the outer edge, at once suggesting that these veins were the channels through which the liquid had been expelled. An examination of grass revealed a similar condition of matters: the moisture was not equally distributed over the blade, but was in drops attached to the tips of some of the blades. These drops, seen on vegetation on dewy nights, are therefore not dew at all, but are an effect of the vitality of the plant.

It is pointed out that the excretion of drops of liquid by plants is no new discovery, as it has been long well known, and the experiments of Dr. Moll on this subject are referred to; but what seems strange is that the relation of it to dew does not seem to have been recognised.

Some experiments were made on this subject in its relation to dew. Leaves of plants that had been seen to be wet on dewy nights were experimented on. They were connected by means of an india-rubber tube with a head of water of about 1 metre, and the leaf surrounded with saturated air. All were found to exude a watery liquid after being subjected to pressure for some hours, and a broccoli leaf got studded all along its edge with drops, and presented exactly the same appearance it did on dewy nights. A stem of grass was also found to exude at the tips of one or two blades when pressure was applied.

The question as to whether these drops are really exuded by the plant, or are produced in some other way, is considered. The tip of a blade of grass was put under conditions in which it could not extract moisture from the surrounding air, and, as the drop grew as rapidly under these conditions as did those on the unprotected blades, it is concluded that these drops are really exuded by the plant. Grass was found to get "dewed" in air not quite saturated.

On many nights no true dew is formed, and nothing but these exuded drops appear on the grass; and on all nights when vegetation is active, these drops appear before the true dew, and if the radiation is strong enough and the supply of vapour sufficient, true dew makes its appearance, and now the plants get equally wet all over, in the same manner as dead matter. The difference between true dew on grass, and these exuded drops, can be detected at a glance. The drops are always exuded at a point near the tip of the blade, and form a drop of some size, while true dew is distributed all over the blade. The exuded liquid forms a large diamond-like drop, while the dew coats the blade with a pearly lustre.

Towards the end of the paper the radiating powers of different surfaces at night is considered, and after a reference to some early experiments on this subject, the paper proceeds to describe some experiments made with the radiation-thermometer described by the author in a previous paper. When working with this instrument it is placed in a situation having a clear view of the sky all round, and is fixed at the same height as the ordinary thermometer-screen, which is worked along with it, the difference between the thermometer in the screen and the radiation-thermometer being observed. This difference in clear nights amounts to from 7° to 10°. By means of the radiation-thermometer the radiating powers of different surfaces were observed. Black and white cloths were found to radiate equally well; soil and grass were also almost exactly equal to each other. Lamp-black was equal to whitening. Sulphur was about 2/3rds of black paint, and polished tin about 1/7th of black paint. Snow in the shade on a bright day was at midday 7° colder than the air, while a black surface at the same time was only 4° colder. This difference diminished as the sun got lower, and at night both radiated almost equally well. In the concluding pages of the paper some less important subjects are considered.

TELESCOPIC SEARCH FOR THE TRANS-NEPTUNIAN PLANET[1]

IN the twentieth volume of the *American Journal of Science*, at page 225, I gave a preliminary account of my search, theoretic and practical, for the trans-Neptunian planet. I say *the* trans-Neptunian planet, because I regard the evidence of its existence as well-founded, and further, because, since the time when I was engaged upon this search, nothing has in the least weakened my entire conviction as to its existence in about that part of the sky assigned; while, as is well known, the independent researches in cometary perturbations by Prof. Forbes conducted him to a result identical with my own,—a coincidence not to be lightly set aside as pure accident.

That five years have elapsed since this coincidence was remarked, and the planet is still unfound, is not sufficient assurance to me that its existence is merely fanciful. In so far as I am informed, this spot of the sky has received very little scrutiny with telescopes competent to such a search; and most observers finding nothing would, I suspect, prefer not to announce their ineffective search.

The time has now come when this search can be profitably undertaken by any observer having the rare combination of time, enthusiasm, and the necessary appliances. Strongly marked developments in astronomical photography have been effected since this optical search was conducted; and the capacity of the modern dry-plate for the registry of the light of very faint stars makes the application of this method the shortest and surest way of detecting any such object. Nor is this purely an opinion of my own. But the required apparatus would be costly; and the instrument, together with the services of an astronomer and a photographer, would, for the time being, be necessarily devoted exclusively to the work. While, however, the photographic search might have to be ended with a negative result, in so far as the trans-Neptunian planet is concerned, there would still remain the series of photographic maps of the region explored, and these would be of incalculable service in the astronomy of the future.

In the latter part of the paper alluded to above, I stated the speculative basis upon which I restricted the stellar region to be examined; also the fact that between November of 1877 and March of 1878 I was engaged in a telescopic scrutiny of this region, employing the twenty-six-inch refractor of the Naval Observatory. For the purposes contemplated I had no hesitation in adopting the method of search whereby I expected to detect the planet by the contrast of its disk and light with the appearance of an average star of about the thirteenth magnitude. A power of 600 diameters was often employed, but the field of view of this eye-piece was so restricted that a power of 400 diameters had to be used most of the time. I say, too, that, "after the first few nights, I was surprised at the readiness with which my eye detected any variation from the average appearance of a star of a given faint magnitude: as a consequence whereof my observing-book contains a large stock of memoranda of suspected objects. My general plan with these was to observe with a sufficient degree of accuracy the position of all suspected objects. On the succeeding night of observation they were re-observed; and, at an interval of several weeks thereafter, the observation was again verified." Subjoined to the original observations are printed these verifications in heavy-faced type.

In conducting the search, the plans were several times varied in slight detail,—generally because experience with the work enabled me to make improvements in method. Usually I prepared every few days a new zone-chart the region of over which I was about to search; and these charts, while containing memoranda of all the instrumental data which could be prepared beforehand, were likewise so adjusted with reference to the opposition-time of the planet as to avoid, if possible, its stationary point. The same thing, too, was kept in mind in selecting the times of subsequent observation. Notwithstanding this precaution, however, it would be well if some observer who has a large telescope should now re-examine the positions of these objects.

Researches in faint nebulæ and nebulous stars appearing likely to constitute a separate and interesting branch of the astronomy of the future, it has seemed to me that the astronomers engaged in this work may like to make a careful examination of some of the stars entered in my observing-book under the category of "suspected objects." The method I adopted of

[1] By David P. Todd, M.A., from the *Proceedings* of the American Academy of Arts and Sciences.

insuring re-observation of these objects was by the determination, not of their absolute, but only of their relative, positions, through the agency of the larger "finder" of the great telescope. This has an aperture of five inches, a power of thirty diameters, and a field of view of seventy-eight minutes of arc. Two diagrams were usually drawn in the book for each of these objects,—the one showing the relation of adjacent objects in the great telescope, and the other the configuration of the more conspicuous objects in the field of view of the finder. Adjacent to these "finder" diagrams are the settings,—to the nearest minute of arc in declination, and of time in right ascension,—as read from the large finding-circles, divided in black and white. The field of vew of the finder is crossed by two pairs of hair-lines, making a square of about twelve minutes on a side by their intersection at the centre. The diagrams in all cases represent the objects as seen with an inverting eye-piece. As the adjustment of the finder was occasionally verified, as well as the readings of the large circles, there should be no trouble in identifying any of these objects, notwithstanding the fact that no estimates of absolute magnitude were recorded. The relative magnitudes, while intended to be only approximate, are still shown with sufficient accuracy for the purpose of the research, and the diagrams are, in general, faithful tracings from the original memoranda.

[Mr. Todd transcribes the observing-book entire.]

PRIME MERIDIAN TIME[1]

ON the first day of the month, the President of the United States, in his message at the opening of Congress, referred to the International Meridian Conference lately convened in Washington, in the following words:—"The Conference concluded its labours on November 1, having with substantial unanimity agreed upon the meridian of Greenwich as the starting point whence longitude is to be computed through 180° eastward and westward, and upon the adoption for all purposes for which it may be found convenient of a Universal Day, which shall begin at midnight on the initial meredian, and whose hours shall be counted from zero up to twenty-four."

The Canadian Institute is peculiarly interested in this announcement. No society, literary or scientific, has taken a more important part in the initiation of the movement to reform our Time-system, of which the success is, to some extent, indicated in the President's words. It therefore appears to me fit and proper that I should recall to your attention the various steps which from time to time have been taken, so that we may possess a record of the events which have led to the now almost general recognition of the necessity for a new notation.

Six years ago on several occasions the meetings of the Institute were engaged in discussing the subject of Time-reckoning and the selection of a Prime Meridian common to all nations. Papers were read and arguments were advanced, with the view of showing the necessity of establishing a cosmopolitan or universal time, by which the events of history might be more accurately recorded, and which would respond to the more precise demands of science, and generally satisfy the requirements of modern civilisation. The *Proceedings* of the Institute for January and February, 1879, give at considerable length the views submitted and the suggestions offered to meet the new conditions of life. While on the one hand it was argued that the introduction of a comprehensive scheme by which time could be universally reckoned was highly desirable, it was equally maintained that the determination of a common Prime Meridian for the world was the key to its success, and that the establishment of such a meridian, as a zero, recognised by all nations, was the first important step demanded.

These *Proceedings* were brought under the notice of His Excellency the Marquis of Lorne, then Governor-General of Canada. In the name of the Institute, they were submitted, in the form of a memorial, with the hope that His Excellency would see fit to lay them before the Imperial Government, that they would by these means obtain the attention of the several scientific bodies throughout Europe, and that some general systematic effort would be made in the right direction to secure the important objects sought to be attained.

Through the good offices of His Excellency, copies of the Canadian Institute *Proceedings* found their way to the British Admiralty, the Astronomer Royal, Greenwich, the Astronomer Royal for Scotland, Edinburgh, the Royal Society, the Royal Geographical Society, the Royal Astronomical Society, the Royal United Service Institute, and other societies of eminence and weight in the United Kingdom. Copies of the papers were likewise sent through the Imperial Government to the governments of the following countries, viz.:—

France,	Germany,
Italy,	Norway and Sweden,
The United States,	Russia,
Austria,	Belgium,
Brazil,	Denmark,
Japan,	The Netherlands,
Spain,	Portugal,
Switzerland,	Turkey,
Greece,	China.

In the year following, the American Metrological Society issued a Report of the Committee on Standard Time. The report bears the name of Mr. Cleveland Abbe, the Chairman of the Committee, and the date of May, 1879. It draws attention to many of the causes calling for the establishment of accurate time, and the attempts made since the establishment of the electro-magnetic telegraph to make the notation of time synchronous. While pointing out that this result had been obtained in Great Britain through the efforts of Prof. Airy, Mr. Cleveland Abbe gave a list of the various observatories on this continent which are in possession of the necessary apparatus and force proper to furnish astronomically accurate time by telegraph. Writing in February, 1880, while giving the resolution adopted by the society, recommending the adoption of accurate time by telegraph from an established astronomical observatory, Mr. Cleveland Abbe points out that the subject of accurate time has been taken up by the Horological Bureau of the Winchester Observatory of Yale College, and that the most perfect apparatus had been received for the purpose of distributing New York time with the highest degree of uniformity and accuracy.

Mr. Cleveland Abbe's own remarks on the subject are of high value. He forcibly points out the difficulties and inconveniences under which railway operations in America labour from the want of a proper system of time. To show this fact in greater force, he gives the 74 standards then followed. These several standards he proposed to set aside and replace by standards each differing one hour, or 15° of longitude.

While recommending this course, the report sets forth that the change could only be regarded as a step towards the absolute uniformity of all time-pieces, and the Society passed resolutions, that absolute uniformity of time is desirable; that the meridian six hours west of Greenwich should be adopted as the National Standard to be used in common on all railways and telegraphs, to be known as "Railroad and Telegraph Time;" that after July 4, 1880, such uniform Standard Time should be the legal standard for the whole country, and that the State and National Legislatures should be memorialised on the subject.

Mr. Cleveland Abbe in this report alluded to the previous *Proceedings* of the Canadian Institute.

The active sympathy of the Marquis of Lorne greatly aided the movement of Time-reform in its early stages. In 1879, in his official position as Governor-General, he had been the recipient of the papers published by the Canadian Institute, and had transmitted them to Great Britain, and through the Imperial Government to the several European centres. In 1880, it was learned that the Report to the American Metrological Society, above alluded to, would shortly be issued. Accordingly, advance copies were obtained from New York, and, together with additional papers issued by this Institute, they were transmitted by His Excellency to the following European Societies, and the special attention of their members was directed to the documents themselves:—

1. The Institut de France	Paris.
2. Société de Géographie	Paris.
3. Société Belge de Géographie	Brussels.
4. Königliche Preussische Akademie der Wissenschaften	Berlin.
5. Gesellschaft für Erdkunde	Berlin.
6. Kaiserliche Akademie der Wissenschaften	Vienna.
7. K. K. Geographische Gesellschaft . .	Vienna.
8. Nicolaievskaia Glavnaia Observatoria .	Pultowa.
9. Imper. Rousskae Geograficheskoe Obschestou	St. Petersburg.

[1] This paper, giving the early history of a movement which is now attracting such general attention, we extract from a recently received volume of *Transactions* of the Canadian Institute.

10. Imper. Akademia Nauk . . . . . St. Petersburg.
11. Société de Géographie . . . . . . Geneva.

By this means attention was obtained for the subject in Europe, and when I submit evidence of the fact, I think you will agree with me, that no little of the success which has attended the movement is owing to our late Governor-General. We must all acknowledge how much we are indebted to him for the great personal interest he has always shown on the subject. We are certainly warranted in forming the opinion, that the dissemination of these papers, under such distinguished auspices, awakened attention to the arguments they contain, and prepared the way for the subsequent action taken at the International Geographical Congress at Venice, at the Geodetic Congress at Rome, and more recently at the Conference at Washington.

Mr. Wilhelm Förster, director of the Berlin Observatory, enters into the subject at length in a paper "Zur Beurtheilung Einiger Zeitfragen, insbesondere gegen die Einführung einer deutschen Normalzeit." [A Review of some considerations on Time, especially against the introduction of German National Uniform Time.]

Mr. Förster proceeds to say: The British Government is now transmitting, through its representatives, although at the same time it declares itself neutral, a proposition which has been published by a society of scientific men in Canada, which aims at the establishment of a cosmopolitan normal datum (Prime Meridian) and of Universal Time, and also the establishment of 24 meridians of an hour apart, by which local time will be absorbed. The first proposal Mr. Förster describes as an important sign of the times and evidently favours it.

He strongly protests against the establishment of a National German Time; but for railway business, and for such matters of communication as require precision, also for the form of expression of all scientific relations to time, Mr. Förster points out that a Universal Time common to the whole world is to be recommended.

Dr. G. von Boguslavski, in the *Verhandlungen der Gesellschaft für Erdkunde* (*Transactions of the Geographical Society of Berlin*), commends the new scheme as it has been put forth in the Canadian Institute papers, and foretells that it will be a matter of fact in a short time.

Col. Aden, Director of the Military School, Belgium, has two papers in the *Bulletin de la Société Belge de Géographie*. He supports the proposal to establish Universal Time, and expresses the opinion that longitude throughout the world should have a common notation, dating from one universally adopted Prime Meridian.

Col. Wauverman, President of the Geographical Society of Antwerp, in the *Bulletin* of that society, 1882, advocates the change, and with ability meets the arguments raised against it, showing them to be groundless and arising from a want of thoroughly understanding the question.

In Spain, the proposals have met with full support. All the papers issued by the Canadian Institute have been translated and published in a paper of 80 pages by the Revista General de Marina. The translator, Don Juan Pastorin, an officer of the Spanish navy, is warm in his commendation of the scheme, and takes a wise and comprehensive view of the whole question. The Spanish Government secured the advantage of this gentleman's services as delegate to the Washington Conference.

M. Otto Struve, the well-known Astronomer and Director of the Imperial Observatory, Pultowa, reports on the papers transmitted by Lord Lorne to the Imperial Academy of Science, St. Petersburg. He gives his adherence to the establishment of Universal Time, based, as suggested, on a Prime Meridian common to the whole globe, and strongly advocates counting the hours in one series up to 24.

In England, the Royal Society considered favourably both the establishment of a Universal Time and the determination of a common Prime Meridian. While the present Astronomer Royal, Mr. Christie, takes a favourable view of the question, his predecessor, Sir G. B. Airy, reported unfavourably. The report of the Astronomer Royal for Scotland, Prof. Piazzi-Smith, is decidedly adverse. These documents have been transmitted to the Institute.

In Italy, the Italian Geographical Society has given its countenance to a work by Mr. Fernando Bosari, who, in a pamphlet of 68 pages, reviews the whole question at length, and lays down three principles: 1. The determination of a Zero-meridian; 2. The establishment of Cosmopolitan Time based upon it; 3. The notation of the hours from 1 to 24 in a continuous series.

The question of Universal Time and the selection of a Prime Meridian is discussed with ability in a paper published by M. Thury, professor at the University of Geneva.

At the meeting of the Association for the Reform and Codification of the Laws of Nations at Cologne, Prussia, in 1881, the question of regulating time on the new system was considered and resolutions moved.

In the same year (1881), the subject occupied the attention of the International Geographical Congress at Venice, at which a delegate from the Canadian Institute attended. The general question was warmly discussed, and resolutions adopted. The appointment of an International Conference to meet at Washington, specially to consider the question, was then suggested by the Canadian delegate, and warmly supported by gentlemen representing the government and scientific societies of the United States. The President of the Congress communicated the resolutions to the Italian Government, and Prince Teano, on behalf of the Italian Government, undertook to conduct the official correspondence. Out of this appears to have sprung the important discussion at the meeting of the International Geodetic Association at Rome, in October, 1883, when the utility of Universal Time was recognised, and a special International Conference for the establishment of a zero-meridian for longitude and time recommended.

Returning to this side of the Atlantic, the question of regulating time for railway, telegraph, and civil purposes generally, was considered at the Convention of the American Society of Civil Engineers, held at Montreal, June 15, 1881, and a committee of men engaged in the management, and familiar with the economy of railways, appointed to examine the question. The committee has reported from time to time. They recognised that a proposition to reform the general time system of the country was a problem beset with difficulties, but it did not appear to them insolvable. It was felt, however, that the question affected so many interests that any change could only be effected by general concurrence.

To attain the end proposed by this society, the papers bearing on the question were printed, and a scheme modified on the *Proceedings* of the Canadian Institute was drawn up, under the title of "Cosmopolitan scheme for regulating time."

I may briefly recall the features of the scheme.

There should be one standard of absolute time, a Universal Day, based on the mean solar passage, at one particular meridian, the Prime or initial meridian for computing longitude. This Prime Meridian, together with the Universal Day, to be observed by all civilised nations.

There should be 24 secondary or hour-meridians established, 15 degrees of longitude apart, beginning with the Prime Meridian as zero.

To distinguish the Universal Day from local days, it should bear the title of "Cosmic Day."[1]

Cosmic Time is intended to be used to promote exactness in chronology, and to be employed in astronomy, navigation, meteorology and in synchronous observations throughout the world. To be employed in ocean telegraphy and generally in all operations non-local in character.

The several 24 meridians to be used as standards for local time around the globe. Applying the system to North America, the effect would be to reduce the standards to four or five, as suggested by the Metrological Society.

A circular, dated March 15, 1882, signed by Mr. John Bogart, the Secretary of the American Society of Civil Engineers, was forwarded to the leading men in railway direction, either as general managers, superintendents, or engineers, and to men of scientific attainments throughout the United States and Canada. The paper thus circulated contained 11 questions, and categorical replies were invited to them.

Replies were received and reported on at a Convention of the Society, held in Washington on May 15, 1882. The scheme submitted was generally and cordially approved.

An emphatic and unanimous opinion was expressed, that there should be established as early as possible a comprehensive system of Standard Time for North America.

[1] [NOTE.—I may remark, that the designation "Cosmic" was first suggested, independently, by two Canadian gentlemen widely separated, by Mr. R. G. Haliburton, then in Algiers, and by Mr. Thomas Hector, of Ottawa. The etymology commends the use of the word. It has been accepted by a number of societies and by many individuals as appropriate and applicable.]

Of those who replied to the queries, 95 per cent. favoured the idea that there should be a common agreement between the standards of time in all countries. That while we must primarily look to our own convenience on this continent, it is proper to aim at eventually attaining general uniformity among all nations.

Seventy-six per cent. were in favour of reducing the standards in North America so that they would differ only by intervals of one hour, and 92 per cent. were in favour of a notation of the hours of the day by a single series from 1 to 24, instead of in two divisions, each of 12 hours.

The character of the replies received indicated that a remarkable unanimity of opinion prevailed in every section of the continent heard from. The Convention accordingly resolved that an attempt should be made to obtain European concurrence to the selection of a Prime Meridian on which a time-system could be definitely based. But, failing to obtain this recognition, the people of the Western Continent should determine a zero-meridian for their own use and guidance.

It was thereupon resolved to petition the Congress of the United States to take the matter into consideration. The American Metrological Society about the same time adopted a similar proceeding. The consequences were that a joint-resolution of the House of Representatives and the Senate was passed, authorising the President of the United States to call an International Conference to fix on and recommend for universal adoption a common Prime Meridian to be used in the reckoning of longitude and in the regulation of time throughout the world.

On the meeting of the American Association for the Advancement of Science in Montreal, in July, 1882, the subject was brought forward, and all the documents were submitted and discussed. It was agreed that the Association should co-operate with other bodies in furtherance of the movement.

On two occasions the Royal Society of Canada has had its attention directed to the matter, and this body has assisted in furthering the determination of the problem by its co-operation and by correspondence with the Government.

While some delay took place in summoning the International Conference by the President, in consequence of diplomatic correspondence on the subject, the question was ripening on both sides of the Atlantic for concerted action. Indeed, a decision with respect to the regulation of local time was anticipated by the railway authorities in North America, who adopted the system of hour-standards which had been prominently brought forward as described.

On November 18 of last year (1883) the new system of regulating railway time on this continent came into operation. There had been several preliminary meetings of railway managers; the last meeting was a Convention held in Chicago the previous October, and it was then determined immediately to carry out the change.

Mr. W. F. Allen, the secretary of this Convention, who also took a prominent part in effecting the adoption of the change, has given a history of the events leading to it. Upon this gentleman mainly fell the labour of arranging details, and he executed the difficult duties assigned to him with consummate ability. In the words of the historian, the transition from the old to the new system "was put into effect without any appreciable jar, and without a single accident occurring." According to this authority the first newspaper to advocate some change was the *Railroad Gazette* for April 2, 1870, and it is claimed that as early as 1869 Prof. Charles F. Dowd, Principal of Temple Grove Ladies' Seminary, Saratoga Springs, proposed a system of meridians based on the meridian of Washington at intervals of one hour, by which railways should be operated, and that an expression of his views was placed in the hands of the President of the New York and Canada Railroad. The proposition appears to have attracted attention in the *Travellers' Official Guide* of 1872. In 1873 it was brought before the Railway Association of America, not now in existence. A committee was appointed to examine into its merits; they failed to recognise its necessity, and recommended that the question of National Standard Time for use on Railways be deferred till it more clearly appeared that the public interest called for it.

Mr. Dowd's efforts to introduce a National Standard Time to meet the difficulties which were being developed were at the time imperfectly appreciated. He, however, has had the satisfaction of seeing a scheme unanimously accepted, and put in operation, which in essential features does not materially differ from that which he advocated; and he himself attended at the meeting of the American Metrological Society, and took part in the proceedings when the details of the new time arrangements were officially narrated.

Prominent among those who have earnestly laboured to advance the movement of time-reform is the distinguished President of Columbia College, New York. Dr. Barnard has from the first taken the deepest interest in the question, and few men have done so much to bring it to a practical issue. In the proceedings of the American Metrological Society for 1881 will be found a paper prepared by Dr. Barnard in 1872, and presented to an association which has since assumed an international character, and is known as the Association for the Reform and Codification of the Laws of Nations. In this paper Dr. Barnard recommends the selection of Greenwich as the Prime Meridian for the world, and he submits the views he held at that early date, which at this hour are of peculiar interest. He points out that "it is becoming a matter of greater importance every day that there should be established some universal rule for defining the calendar day for all the world."

I have alluded to the valuable report of Prof. Cleveland Abbe, of the United States Signal Service, to the Metrological Society, and I cannot deny myself the pleasure of acknowledging the services of the gentlemen with whom I have been associated on the special committee on Standard Time of the American Society of Civil Engineers, Mr. Charles Paine, of New York; Mr. Theodore N. Ely, of Altoona, Pennsylvania; Mr. J. M. Toucey, of the Hudson River Railway; Prof. Hilgard, Coast Survey, Washington; Prof. T. Egleston, of Columbia College: General T. G. Ellis, of Hartford, now unfortunately deceased, and Mr. John Bogart, Secretary of the Society.

The American Society of Civil Engineers, since meeting in Montreal, in 1881, has made persistent and continuous efforts in the common interest to advance the movement of time-reform, having greatly aided in bringing about the important change carried into effect a year ago. This Society is now directing attention to a reform of scarcely less importance, the notation of the hours of the day. At the Buffalo convention in June 1884, this particular question received prominent consideration in the address of the President, as well as in the report of the special committee. Since that date a correspondence has taken place between the Secretary and the railway managers in the United States and Canada. Already replies have been received from the representatives of some 60,000 miles of railway, 98 per cent. of whom have given expression to their sympathy with the movement, to abandon the old practice of halving the day, designating the two sets of 12 hours by the abbreviations A.M. and P.M., and are prepared to adopt a simple notation of 1 to 24 in a single series. The great telegraph interests of the country are likewise in full sympathy with it. The President of the Western Union Telegraph Company, Dr. Norwin Green, states that their telegraphic traffic is equal to the transmission of 44,000,000 messages a year, and the general adoption of the 24 o'clock system (as it has been designated), would be cordially welcomed by telegraphers. It would reduce materially the risk of errors, and to the company over which he presides, he says it would save the transmission by telegraph of at least 150,000,000 letters annually.

The branch literature bearing on the two questions of Universal Time and the establishment of a Prime Meridian, has been enriched by a series of papers which have appeared during the past year in the *International Standard*, a magazine published in Cleveland, Ohio. These papers are by the following gentlemen connected with the International Institute:—Rev. H. G. Wood, of Sharon, Pennsylvania; Prof. C. Piazzi-Smyth, Astronomer Royal for Scotland; Prof. John N. Stockwell, Astronomer, Cleveland; Mr. Jacob M. Clark, C.E., New York; Mr. William H. Searle, Pennsylvania; the late Abbé F. Moigno, Canon of St. Denis, Paris; Commodore Wm. B. Whiting, U. S. Navy; Mr. Charles Latimer, C.E., Cleveland; and others.

It will be seen from what I have submitted, that the proceedings have neither been few nor without success, and that since this Institute published the first issue of papers on Time and Time-reckoning, the subject has received much attention on both sides of the Atlantic. Societies with kindred pursuits, men of recognised merit in the scientific world, have turned to its examination and aided in its development. Some few men have acted in concert. The labours of others have been independent. Some of these names I have been able to record, but I fear that I neglect to include many of eminence because they are not known to me. It is this varied and widely diffused effort which has rendered possible the realisation of the practical results which I have the gratification to record, and all the members of this Society must equally join in the common satisfaction in the measure of success which has been achieved.

Six years back, when the subject was discussed in this hall, there were probably not a few who viewed the propositions then submitted as merely fanciful theories. Others, who did not refuse to recognise their bearing, entertained the feeling that many grave difficulties presented themselves to interfere with any successful attempt to reform or modify usages so ancient as the computation of time. But the Institute, as a body, was hopeful. The action taken by the Council to extend the field of discussion and awaken the attention of foreign communities, evinced confidence, and we may now ask, was this confidence justified? What are the facts to-day? Twelve months have passed since an important change in the notation of railway time was made with general approval throughout the length and breadth of North America; a revolution in the usages of 60,000,000 of people has been silently effected and with scarcely a trace that it has happened. That proceeding has been followed by events of equal importance. On October 1 last a body of accredited delegates from the different nations, on the invitation of the President of the United States, met in Conference to consider the problem first submitted to the world by this Institute. The delegates were the representatives of 25 civilised nations. The Conference continued during the whole month of October, and, as a body, they came to conclusions affecting all peoples living under our theories of civilisation.

It was early understood that a determination with respect to Universal Time was not possible without the general recognition of a Prime Meridian. Hence the importance attached to its choice, that it should be universally accepted.

SOCIETIES AND ACADEMIES

London

Royal Society, December 10, 1885.—Abstract of a Paper on "Preliminary Results of a Comparison of Certain Simultaneous Fluctuations of the Declination at Kew and at Stonyhurst during 1883-84, as recorded by the Magnetographs." By the Rev. S. J. Perry, F.R.S., and Prof. B. Stewart, F.R.S.

The authors remark that such fluctuations almost always occur as couplets or groups of couplets; a couplet meaning first an ascent and then a descent, or the reverse. In their opinion this duality and the other facts of their paper can best be explained by supposing that a recorded magnetic fluctuation is the joint result of two causes: the one of these being a true magnetic change, and the other a secondary current caused by this change. The secondary current would probably appear as an earth-current. Its maximum strength would depend on the maximum rate of magnetic change, but as this last element is quite unknown, we may perhaps suppose that this maximum strength will be practically proportional to the mean rate of magnetic change.

On this supposition the authors suggest the following formula as capable of being used as a preliminary working hypothesis.

Let K denote the observed Kew change, and k the true magnetic change at Kew, also let t represent the duration; then $K = k\left(1 \mp \frac{\alpha}{t}\right)$ where α is a constant. Also if S represent the observed simultaneous Stonyhurst change, then $S = k\left(\beta \mp \frac{\gamma}{t}\right)$, the sign − being applicable to the first limb, and the sign + to the second limb of the couplet.

It follows from this that $\frac{S}{K} = \frac{\beta \mp \frac{\gamma}{t}}{1 \mp \frac{\alpha}{t}}$, or, in other words, that the ratio between the Kew and Stonyhurst observed disturbances will be a function of the duration, quite apart from all theoretical considerations, which can only in the meantime be regarded as pointing out a method of treatment. The authors then practically discuss their results, and have obtained the following preliminary conclusions:—

(1) S is always greater than K, or the ratio $\frac{S}{K}$ is always greater than unity.

(2) This ratio appears to depend in some way on the duration of the disturbance;

(3) But not, as far as can be seen at present, upon its magnitude.

Finally, they hope to make a more extended investigation of the subject, going over a greater number of years, and perhaps adding to their methods of treatment.

"On the Limited Hydration of Ammonium Carbamate." By H. J. H. Fenton.

The hydration of ammonium carbamate affords an example of a chemical action of the simplest type, namely, the direct union of two simpler molecules to form one more complex—

$$CO(NH_2)(ONH_4) + OH_2 = CO(ONH_4)_2.$$

There are but few actions of this type which can be investigated when all the substances concerned are in the liquid state, and all extraneous matter absent.

In a former paper it was shown that ammonium carbamate, when acted upon by sodium *hypochlorite* in presence of sodium hydroxide, yields one half of its nitrogen in the free state, the other half remaining in the form of sodium carbamate—

$$2CO(NH_2)(ONH_4) + 3NaClO + 2NaOH = 2CO(NH_2)(ONa) + 3NaCl + 5OH_2 + N_2.$$

Sodium *hypobromite* at once decomposes sodium carbamate, yielding the nitrogen in the free state. This, in fact, is claimed as a specific reaction for carbamates, since no other substance yet investigated will yield free nitrogen by action of a hypobromite *after* the completed action of a hypochlorite.

Based upon this reaction, then, we have a direct and simple method of determining the amount of carbamate existing in a solution at any given time.

Experiments were conducted with a view of examining the influences of time, mass, and temperature upon the hydration of ammonium carbamate, and also the reverse action, namely, the dehydration of normal ammonium carbonate into ammonium carbamate. The hydration is expressed by the ratio—

$$\frac{\text{molecules of water assimilated}}{\text{molecules of carbamate taken}}.$$

(1) *Influence of Time.*—Solutions of ammonium carbamate of different strengths were examined at stated intervals. In all cases the action proceeds rapidly at first, becomes progressively slower, and finally reaches a limit short of complete hydration.

The time required to reach a determinate state of hydration is less as the relative number of water-molecules is greater.

(2) *Influence of Mass.*—The hydration is shown to be a function of the number of water-molecules present. As far as the action could be legitimately studied, the minimum hydration corresponded to the case in which the substances are present in equal molecular proportions.

(3) *Influence of Temperature.*—The hydration is in all cases less, as the temperature is lower. Probably at a sufficiently low temperature the hydration would be practically *nil* when the substances are present in equal molecular proportions—*i.e.* ammonium carbamate and water would practically not combine at all.

(4) *Dehydration of Normal Ammonium Carbonate.*—It was shown that this salt undergoes dehydration in solution, becoming in part converted into carbamate. The dehydration is greater, as the relative number of water-molecules is less. It seems not unlikely that if the same relative number of molecules could be started with, the same equilibrium state between carbamate, carbonate, and water, would be arrived at for the same temperature, whether ammonium carbamate or normal ammonium carbonate were initially taken.

Since there is a tendency for normal ammonium carbonate to become in part dehydrated in aqueous solution, and for the system to come to a state of equilibrium where the carbamate and carbonate co-exist, it seems probable that the hydrolysis of urea under the action of ferments may be less simple than is usually represented. The author proposes to attack the problem by a method based on the actions of sodium hypochlorite and hypobromite, by means of which it is possible to detect, and quantitatively estimate, urea, carbamic acid, and ammonia, when all present in the same solution. A preliminary trial of the method gave satisfactory results.

Geological Society, December 16, 1885.—W. Carruthers, Vice-President, in the chair.—Charles John Alford, Samuel Blows, James Warne Chenhall, William Farnworth, Paget

Henry Cater Fulcher, and Harold Temple Wills, were elected Fellows of the Society.—The following communications were read:—Old sea-beaches at Teignmouth, Devon, by G. Wareing Ormerod, F.G.S. The author stated that while old records show that no important changes have taken place in the level of the Teignmouth district during the historical period, the excavations made in recent drainage-operations in the present year showed the existence of at least two series of beaches. The oldest sea-beach, which is a few feet above the present sea-level, was partly washed away and then covered up by later deposits exhibiting evidence, in a number of delicate bivalve shells in an unbroken condition, of having been deposited in a calm sea.—On the gabbros, dolerites, and basalts of Tertiary age in Scotland and Ireland, by Prof. John W. Judd, F.R.S. In previous papers published in 1874 and 1876, it has been demonstrated by the author that there exist in Scotland and in Hungary igneous rock-masses presenting the most perfectly crystalline characters, and belonging to the Tertiary period. It was further shown that such highly crystalline, plutonic rocks are seen passing insensibly into volcanic rocks of the same chemical composition—gabbros into basalts, diorites and quartz-diorites into andesites, and quartz-andesites and granites into rhyolites—the lavas in turn graduating into the perfectly vitreous types known as tachylites and obsidians. The present paper deals with the basic rocks of Western Scotland and Northern Ireland, which are shown to exhibit the most marked analogies with rocks of the same age in the Faroe Isles and Iceland; these facts lend strong support to the doctrine of the existence of petrographical provinces. The Tertiary age of the Scotch and Irish rocks is placed beyond dispute by the fact that they overlie unconformably the youngest members of the Cretaceous system, and are interbedded with stratified deposits of Lower Tertiary age. With regard to the nomenclature of these rocks, the identification of the more crystalline forms with the gabbros, which was made by Zirkel and Von Lasaulx, is supported; while the use of the term "dolerite" as a convenient one for the connecting links between the gabbros and basalts is advocated. Of the original minerals contained in these rocks, plagioclase felspar (ranging in composition from anorthite to labradorite), augite, olivine, and magnetite, are regarded as the e sential ones; while enstatite, biotite, chromite, picotite, and titanoferrite are among the most frequently occurring accessories. It is shown, however, that these original minerals may belong to different periods of consolidation. The Secondary minerals are very numerous, including quartz, epidote, zoisite, hornblende, serpentine, and zeolites, with many other crystallised and uncrystallised substances. There are remarkable variations in the relative *proportions* of the original minerals in different examples of the rock; and by the complete disappearance of one or other of the constituents, the gabbros are sometimes found passing into picrites, eucrites, or troctolites. In their microscopic structure these rocks present many interesting features. From the highly crystalline gabbros there are two lines of descent to the vitreous tachylites: one through the *ophitic* dolerites and basalts, and the magma-basalts wtth skeleton-crystals; and the other through the *granulitic* dolerites and basalts, and the magma-basalts with granular microliths. The former are shown to result from the cooling down of molten masses which were in a state of perfect internal equilibrium, while the latter were formed when the mass was subject to movement and internal strain. It is shown that in the most deeply-seated of these rocks (gabbros) the whole of the iron-oxides combines with silica; but, as we approach the surface, the quantity of these oxides separating as magnetite increases, until it attains its maximum in the tachylites. In all the varieties the order of separation of the different minerals is shown not to depend solely on chemical causes, but to be influenced by the conditions under which the rocks have cooled down. Although these rocks are not highly-altered ones, yet they afford admirable opportunities of studying the incipient changes in their constituent minerals. The nature of these changes is discussed, and they are referred to the following causes:—(1) The corrosive action of the surrounding magma on the crystals; (2) the changes produced by solvents acting under pressure in the deep-seated masses (these have been already described under the name of "schillerisation"); (3) the action of heated water and gas escaping at the surface; (4) the action of atmospheric agents on the rocks when exposed by denudation; and (5) the changes induced by pressure during the great movements to which rock-masses are subjected.

Physical Society, December 12, 1885.—Prof. Guthrie, President, in the chair.—Mr. C. F. Casella and Prof. T. E. Thorpe were elected Members of the Society.—The following papers were read:—On a magneto-electric phenomenon, by Mr. G. H. Wyatt. The author had conducted a series of experiments with a view of testing experimentally an expression obtained by Mr. Boys for the throw of a copper disk suspended by a torsion-fibre between the poles of an electro-magnet, when the current was made or broken, and communicated by him to the Society on June 28, 1884. Disks of various metals and of various dimensions were used, the results being such as to agree with the theory within narrow limits. It was, however, found that when the throw of the disk was used to measure the magnetic field, the value obtained from the throw at break was uniformly greater than that obtained on making the current. Prof. S. P. Thompson observed that the case presented was analogous to that of the ballistic galvanometer, and that for the theory it was necessary that the magnetic field should be made and destroyed before the disk had moved sensibly. Mr. Boys believed that the results of the experiments showed this to be the case, since the result of such a movement would be to increase the throw on breaking the current when the disk made an angle of less than 45° with the lines of force, and to decrease it when the angle was between 45° and 90°, whereas no such variation from the theoretical result was observed.—On some thermodynamical relations, by Prof. William Ramsay and Dr. Sydney Young. In this paper experimental proof is given of the following relations:—(1) The amount of heat required to produce unit increase of volume in the passage from the liquid to the gaseous state, at the boiling-point under normal pressure, is approximately constant for all bodies. (2) If these amounts of heat be compared at different pressures, for any two bodies, then the ratio of the amount at the boiling-point under a pressure, p_1, to the amount at another pressure, p_2, is approximately constant. (3) The products of the absolute temperature into the rate of increase of pressure with rise of temperature are approximately the same for all stable substances. (4) The rate of increase of this product with rise of pressure is nearly the same for all stable substances. (5) A relation exists between the absolute temperatures of all bodies, solid or liquid, stable or dissociable, which may be expressed in the case of any two bodies by the equation

$$\frac{T_A}{T_B} = \frac{T'_A}{T'_B} + c(T'_A - T_A),$$

T_A and T_B being the absolute temperatures of the two bodies corresponding to any vapour-pressure; T'_A and T'_B, absolute temperatures at any other pressure; and c, a constant which may be zero or a small positive or negative quantity. (6) The variations from constancy of the expression $t\frac{dp}{dt}$, though small, may be expressed by a similar equation. (7) If L_A, L_A', L_B, and L_B', represent similar relations of latent heat at different pressures, the same for A and B, it appears probable that

$$\frac{L_A}{L_A'} = \frac{L_B}{L_B'} + c(T'_A - T_A).$$

(8) The ratio of the heats of vaporisation of any two bodies at the same pressure is approximately the same as that of their absolute temperatures at that pressure. The authors conjecture that this statement is also true of dissociating bodies. A large part of the experimental work consisted in obtaining the relation between vapour-pressure and temperature of different substances, values of $\frac{dp}{dt}$ had been obtained from these observations in two ways, by plotting curves with t and p as co-ordinates and drawing tangents, and by the method of differences. Prof. Perry suggested that the curve should be expressed in such a form as

$$\log p = \alpha - \frac{\beta}{t} - \frac{\gamma}{t^2},$$

which Rankine has shown to be a very true expression for the relation between pressure and temperature, and that $\frac{dp}{dt}$ should be obtained from this by differentiation. Prof. Guthrie hoped the authors would experiment upon the vapour-tensions of mixed liquids, a subject to which he had himself given some attention.

EDINBURGH

Royal Society, December 21, 1885.—Prof. Douglas Maclagan, Vice-President, in the chair.—Mr. J. Y. Buchanan, communicated a paper on the temperature of Loch Lomond and also one on oceanic islands and shoals.—Prof. Herdman discussed elaborately the phytogeny of *Tunicata*.—Mr. John Aitken gave a communication on dew, which will be found in full at p. 256.—Mr. Frank E. Beddard read a paper on the structure of *Lumbricus complanatus*, Dugès.—In a paper on the salinity of the water about the mouth of the Spey, Messrs. H. R. Mill and T. Morton Ritchie show that the sea-water slowly forces its way like a wedge between the river-water and the bottom as the tide rises, and dams back the water further up the stream, while the surface-water always remains quite fresh, and a brackish zone separates the two strata. When the ebb sets in the salt water runs out very rapidly, and before half ebb there is only fresh water inside the bar. The salinity of the water in Spey Bay was also studied. The river-water could be traced as a stream sweeping to the north-east, with a sharply-defined western margin. Alkalinity and temperature observations were also given.—Mr. A. Wynter Blyth discussed the distribution and significance of micro-organisms in water.

January 4, 1886.—The President submitted notes on the recent experiments at the South Foreland lighthouse.—Mr. Omond, of the Ben Nevis Observatory, communicated an account of the glories, halos, and coronæ observed there. The small number of glories seen is remarkable. Only four have been noticed since the Observatory was established.—Prof. Crum-Brown read a note on the simplest form of half-twist surface.—The Rev. T. P. Kirkman submitted a discussion of the linear section *PR* of a knot M_n, which passes through two crossings, *P* and *R*, which meets no edge, and which cuts away a $(3 + r)$-gonal mesh of M_n.—Messrs. Rainy, Ellis, and Clarkson gave an account of the exploration of the central portion of the field of a Helmholtz galvanometer.—In a paper on systems of colliding spheres, Prof. Tait showed that Maxwell's law of the distribution of energy between two different sets of molecules is erroneous. If two sets of molecules at a given temperature and pressure be mixed, the resultant temperature and pressure will be the same, but the average kinetic energy of the less massive molecules will exceed that of the more massive molecules. In the case of hydrogen and oxygen the excess will be 25 per cent.

Paris

Academy of Sciences, January 4.—M. Jurien de la Gravière, President, in the chair.—On the potential of two ellipsoids, by M. Laguerre.—Researches on the sulphur of antimony, by M. Berthelot. Here the author determines the measure of the heat of formation of this compound under its various conditions, that of its chlorides and oxichlorides having already been ascertained by MM. Thomsen and Guntz.—Remarks on Dr. A. Sprung's treatise on meteorology ("Lehrbuch der Meteorologie"), recently published at Hamburg, by M. Faye. The author's comments are confined chiefly to the vexed question of the ascending or descending movement of the air in whirlwinds or cyclones. Three points he considers now settled: (1) that the movement of translation is inexplicable according to the old theory; (2) that this rapid movement of translation corresponds with the upper cirrus-bearing currents; (3) that a descending movement cannot be denied within the cyclones themselves. Another step, and the old ascending will give place to the new descending theory.—Note on the differential invariants of M. Halphen, by Prof. Sylvester.—Note on the angular movement which a vessel takes on a wave of given size and velocity, by M. L. de Bussy.—Rectangular co-ordinates and ephemeris of Fabry's comet, by M. Gonnessiat.—Note on the new star in Orion, by M. Ch. Trépied. The magnitude of this star is 6·7, its colour an orange-red, and its spectrum very remarkable, showing six dark bands, two in the red and orange, four in the green and blue; bright lines have also been doubtfully detected in the green.—Note on the transformation of the Fuchsian functions, and on the reduction of the Abelian integrals, by M. H. Poincaré.—A tentative application of the calculus to the study of colour sensations, by M. R. Feret.—On the emetics of tellurium, by M. Daniel Klein. The author has succeeded in preparing some tartrotelluric emetics with the tellurites of the alkaline bases, which are alone soluble, and treating them with tartaric acid in due proportion.—On the transformation of the essence of turpentine to an active terpilene, by MM. G. Bouchardat and J. Lafont.—Note on the employment of the metallic oxides for the purpose of detecting in wines colouring substances derived from coals, by M. P. Cazeneuve.—Note on the cultivation of beet-root in the Wardrecques district, Pas-de-Calais, during the year 1885, by MM. Porion and Dehérain.—On the toxic action of the alkaline salts, by M. A. Richet. From a series of experiments made on fishes, pigeons, and guinea-pigs, the authors conclude that in absolute weight the metals are the less toxic the higher their atomic weight, which reverses the law formulated by Rabuteau; also, that the chlorides are, in absolute weight, more toxic than the bromides, and these than the iodides. But, with equal molecular weight, the reverse is the case. In general the alkaline salts are toxic through their chemical molecule, and the higher the weight of this molecule the more toxic it becomes, although the difference is slight and the molecule always about equally toxic.—On the circulation in the ganglionary cells, by M. Alb. Adamkiewicz.—On the morphology of the ovary in insects, by M. Armand Sabatier.—Note on the trunks of fossil fern-trees occurring in the Upper Carboniferous formations, by MM. B. Renault and R. Zeiller.—On the present value of the magnetic elements recorded at the Observatory of the Parc Saint-Maur.—Notes were presented by M. Ch. Beaugrand, on the meteoric dust collected in the atmosphere on November 27–30, 1885; by M. L. Sandras, on the modifications of the human voice by means of inhalations; and by M. Durif, on a remedy for diseased vines.—This number of the *Comptes rendus* contains a complete list of the members of the Academy on January 1, 1886, and announces the election of M. Gosselin as Vice-President for the current year.

CONTENTS

THURSDAY, JANUARY 21, 1886

THE EAST ANGLIAN EARTHQUAKE OF 1884

Report on the East Anglian Earthquake of April 22, 1884. By Raphael Meldola, F.C.S., &c., and William White, F.E.S. Drawn up by R. Meldola, and read in abstract at the meeting of the Essex Field Club, February 28, 1885. (London: Macmillan and Co.; and the Essex Field Club, Buckhurst Hill. 1885.)

FORTUNATELY for this country we have not been called upon to notice a report of such an earthquake as that which is chronicled in the volume before us since this journal came into existence. Indeed, the authors state that no shock approaching it in intensity has been experienced in the British Islands for at least four centuries. A brief notice of the occurrence was given in our columns (vol. xxx. pp. 17 and 60) by Mr. Topley, and we now have a complete scientific account drawn up by Prof. R. Meldola and presented to the Essex Field Club as a special memoir embodying the results of his investigation in conjunction with his colleague, Mr. William White. The book consists of about 225 pages of readable matter with four maps and numerous illustrations, and the Essex Field Club has certainly earned the gratitude of scientific men in enabling the authors to give publicity to this final result of their labour.

Earthquakes may be considered from three distinct points of view: dynamical, geological, and meteorological or cosmical. The first deals with the purely mechanical aspect of earthquake motion, the second with the immediate cause or causes of these disturbances and their effects as determined by geological conditions, while the last, which is at present the most obscure branch of the subject, deals with the periodicity of earthquakes and their connection with other natural phenomena. The present shock is dealt with from each of these standpoints.

Of the eight sections into which the Report is divided the first is entirely historical, and the authors give a catalogue of all the British earthquakes which have produced structural damage, the records commencing in A.D. 103 and ending with the Nottingham shock of 1881, which slightly damaged a building at Tackley. This list comprises about sixty records, and the authors acknowledge their indebtedness to Mallet's British Association Catalogue, which has greatly facilitated their work of compilation. One very interesting circumstance brought out by this part of the inquiry is that the seat of the present earthquake has been exceptionally free from seismic disturbance since the beginning of authentic history, and it further appears that there have been altogether only about half-a-dozen shocks in Britain since this period which can be compared in their destructive effects with that of 1884.

The second section gives a brief description of the preparation of the Report and the methods adopted for securing the most complete and trustworthy information as soon as possible after the event. Amongst those to whom the authors express their obligation are Mr. G. J. Symons, F.R.S., who had himself made a personal inspection of the scene of damage the day after the shock, and Mr. J. C. Shenstone, of Colchester, who appears to have supplied much valuable local information.

Under the third section, which is headed "General Characters of the Disturbance," we have a statement as to the extent of the shock, which brings out very forcibly the unpleasant fact that our little island is not quite so "tight," as the popular song would have us believe. It seems that the sensible vibrations extended over at least 50,000 square miles of country. An estimate of the intensity is also given which is compared with that of the great Lisbon catastrophe of 1755, the authors arriving at the conclusion that the present shock was about one-twentieth the intensity of the former. In support of the statement that "the earthquake occurred during a period of general seismic activity throughout the world" we have a list of all the British and the more violent of the European earthquakes which have occurred since the beginning of the year 1881. We need only remind our readers that during this period occurred the disasters in Ischia and Chios, the cataclysm in the Sunda Straits, and, more recently, the great Spanish earthquakes, all of which have already been noticed in our columns. With reference to the meteorology we are informed very explicitly that "the evidence is conclusive that no special meteorological conditions preceded, accompanied, or succeeded the disturbance of last April in direct relationship to that event."

In treating of the nature and duration of the movement, and other points of importance which find place in this third section, the authors give a concise account of the general characters of earthquake motion as derived from the observations of modern seismologists, and especially from those made in Japan by Profs. Milne and Ewing, to whose labours constant reference is made throughout the Report. The following conclusion, supported by observations made at Heybridge and Ipswich, is arrived at:—

"There is every reason to believe that the earthquake with which we are dealing was precisely similar in character to those frequent shakings which have been so thoroughly studied in the Plain of Yedo. As in the case of the latter, if our earthquake had been made to trace the story of its own movement on a series of seismographic plates, we should no doubt have seen the gradually commencing tremor increasing in amplitude and complexity till the 'shock' and destruction occurred, and then again dying gradually out."

In the fourth section we have a discussion of the nature and amount of the structural damage, from which it appears that in an area of fifty to sixty square miles damage was caused to 1213 houses and cottages, twenty churches, and eleven chapels.

The "Descriptive Report," which comprises the next section, occupies over 100 pages of the volume, nearly one-half of this portion being devoted to a detailed description of the observations in the area of structural damage made on the ground by Prof. Meldola, Mr. T. V. Holmes, F.G.S., President, and Mr. W. Cole, Secretary, of the Essex Field Club. Many illustrations of peculiar forms of damage are given, and there can be no doubt that the observations recorded in this section will be not only of local interest but also of use to engineers and others who occupy themselves with the important question of construction in earthquake countries.

In summarising this portion it is stated that "the main axis of disturbance extends on each side of a line about five miles in length, having a direction north-east and south-west from Wivenhoe to Peldon. Along this axis the greatest intensity was manifested, as shown by the large percentage of dislodged chimneys, dismantled roofs, &c., and more especially by the fracturing of solid masonry." Following this summary there are the complete records from other parts of Essex and all the other counties over which the disturbance extended. Among the former we notice a very full report from Bocking, furnished by Mr. E. B. Knobel, Sec.R.A.S. It is of interest also to observe how widely the shock was felt over London; records are given from every quarter of the town, and we can but feel thankful that the "axis of disturbance" was not nearer home, or the destruction to life and property would have been most disastrous. A glance at the map, giving the general distribution of the shock, shows that the vibrations were felt as far off as Altrincham in Cheshire, at Sidbury in Shropshire, Street in Somersetshire, Exeter, the Isle of Wight, and across the Channel at Boulogne and Ostend.

The next section will be of special interest to geologists. It is headed "The Earthquake in Relation to Geological Structure," and the first portion deals with the effects of the shock upon underground waters. These effects are, briefly, the raising of the water-level in deep wells near the origin, the falling off of the supply to surface wells, and the rendering turbid of the water derived from the Chalk at Canterbury and in surface wells nearer the centre of the disturbance. The records kept by the Underground Water Committee of the British Association have enabled the authors to give a most valuable series of measurements made at Bocking on behalf of this Committee by Mr. D. Radford Sharpe.

One of the most important practical considerations in connection with earthquake damage is the effect of the subsoil and the position of buildings with respect to the general physical features of the district. This branch of the subject is fully dealt with in the present geological section of the Report, and the authors point out that, owing to the circumstance of the shock having originated beneath a district consisting entirely of London Clay and drift deposits, no very definite conclusions can be drawn as to the effects of the superficial geology in determining the distribution of the damage. They incline to the view that the damage was increased in some cases by the situation of buildings at the junction of different formations, where, in accordance with well-known dynamical principles, the earth-wave undergoes reflection and refraction. A considerable amount of evidence is given to show that both in this and other earthquakes there is a tendency for the shock to make itself felt with special distinctness along "free margins, such as coast-lines, river-valleys, and lines of outcrop, because in these cases there is no resistance offered in one direction to the vibrating particles in their outward movements."

In connection with other geological considerations the authors state that their seismic axis corresponds in direction with the coast-line at this part of Essex, and this fact appears to be in harmony with the theory first put forward by Prof. J. P. O'Reilly. Several pages are devoted to a critical discussion of the evidence furnished by the records from beyond the London Basin, from which it distinctly appears that the shock was spread outwards along the older rocks, owing to the superior "seismic conductivity" of these beds.

In speculating upon the cause of the earthquake the authors display great caution. Having dismissed the view of the shock having been due to volcanic agency they go on to say:—

"The most feasible explanation, in so far as it is safe to hazard any explanation at all, appears to be that of the sudden rupture of deep-seated rocks under a state of strain, the snap and shock accompanying such a fracture being quite competent to produce the effects observed. The precise formation in which this rupture may have occurred cannot even be conjectured; but the great extent of the shock, on the one hand, and on the other the absence of any perceptible change of surface-level, appear to point to a tolerably deep-seated origin."

It is then pointed out as a very significant fact that the axis of the present earthquake corresponds in direction with known faults or other disturbances in the Chalk beneath Essex, Suffolk, and Cambridgeshire, and with that of the well-known Deptford fault.

In the seventh section there are collected a number of miscellaneous observations which could not well find place in the preceding portions of the Report. Mallet's method of determining the "angle of emergence" by the cracks in buildings has been found useless in the present earthquake, and the authors wisely state:—

"We have not thought it advisable to give any calculations of the depth of the origin of the disturbance, being convinced that under the present circumstances such determinations would only give a fictitious semblance of certainty to the results."

A full discussion of the time-records is then given, and the mean velocity of propagation of 9183 feet per second deduced from the most trustworthy. The remainder of this section contains "Observations on Direction," "Personal Experiences of Direction," "Order of Succession of Phenomena," the "Direction as given by Clock-stoppages," and an important sub-section on the twists of chimneys.

The eighth and last section gives a general summary of the whole work. In a postscript, two observations of considerable interest are recorded, the first being the registration of the shock and subsequent earth-tilt at Leeds by a barograph, and the second the displacement of Mr. C. L. Prince's equatorial at the Crowborough Observatory in Sussex. The volume concludes with a short appendix, which relates to the list of British earthquakes.

SYSTEMATIC SMALL FARMING

Systematic Small Farming. By Robert Scott Burn. (London: Crosby Lockwood and Co., 1886.)

THIS volume may be divided into two parts. In the first few chapters the author shows, with considerable clearness, the disadvantages under which small farmers or peasant proprietors are placed. The topic is one which has recently been discussed in connection with legislative projects looming upon the political horizon, and Mr. Scott Burn has contributed towards its elucidation. "While he would be glad to see a limited extension—and which he believes would for natural reasons, after all, be indeed but limited—of small farming, with true peasants or agricultural labourers as the farmers, we must unhesitatingly deprecate any extension based upon the system we have heard so persistently propounded by certain politicians, through the platform or press, and this we do, if for no other reason than in the true interests of the nation" (p. 98). This sentence gives a fair idea both of the literary style of the author and of the tendency of his teaching. With the general conclusion we agree.

While Mr. Robert Scott Burn is, so to speak, "sound" upon the "impracticalness" of the idea of a great extension of small farms in England as a means of improving our agriculture or the well-being of our population, he sees in the small farm an amusement and healthful occupation for those who can afford the luxury of losing a little money. It is apparently with a view to enabling such persons, if not to make more, to lose less, that the second part of the volume is specially designed. Leaving "the wild and revolutionary scheme," he therefore proceeds leisurely to examine the methods and conduct of the small farmer upon his small farm of some half-dozen acres in extent. Into details it is not for us to follow Mr. Burn. He informs us in the preface that the basis of the present volume is a former one which appeared some years ago under the title of "The Lessons of My Farm." That work "was designed to convey to persons interested especially in the subject of small—or, as they are frequently termed, amateur—farms, a general yet a sufficiently practical notion of what the work of such farms was." On reading through the chapters devoted to his practical instruction of the small farmer we are struck with the evidently large proportion of the "basis."

Bearing the date of 1886, the illustrations, examples, and quotations are chiefly borrowed from sources extending, from 1830 to 1860, that is, with the exception of the chapters devoted to *ensilage*. Most farmers would elevate their eyebrows at the suggestion to raise their mangel in seed-beds, and plant them out like cabbages. The result would no doubt be a greatly diminished crop. Yet Mr. Burn says: "I would recommend the reader to try the method." It appears that it was in 1830 that a M. Kœchlin, who cultivates weeded plants, asked why beetroot was not raised upon a seed-bed. But mangel-wurzel is *not* beet, and as well might it be proposed to transplant swedes because they are allied to cabbages as to recommend for mangel what may have been found suitable for beet. This love of the practices of 1830, 1855, 1860, beyond which latter date Mr. Scott Burn rarely ventures except with reference to ensilage, is accompanied by a curious ignoring of the newer literature bearing upon the feeding-stall, the dairy, and the field. Mr. Horsfall and Mr. C. Lawrence, long since retired, if not dead; contributions of Dr. Lyon Playfair, long overgrown with mould; Liebig and Anderson, both long since passed away—these are the authorities quoted. On the other hand, Sir John B. Lawes, although once, in an appendix, obscurely mentioned as Mr. J. B. Lawes, is never quoted or cited on any of the numerous subjects handled. In treating of dairy cattle we are instructed from the experience of M. Lejeune of a Belgian agricultural school obtained in the years 1855 and 1856. At p. 347 we are presented with illustrations of dairy implements and utensils. They consist of three crocks, a milk-strainer, two "butter-sticks" (Scotch hands), and a cream-skimmer. No churn, cheese-tub, curd-breaker, butter-tub, vats, presses, butter-worker, curd-mill, &c., are even mentioned. A cream-raising machine is alluded to, but we are quite at a loss to know what is meant—perhaps a cream-separater. A cream-raising machine strikes us as fantastic. In the present day we are, perhaps, too liable to forget past experiences; but when the results of recent experiments, conducted with modern precision and modern apparatus, lie around us in almost reckless profusion; when the values of foods, the effects of dietaries upon cows and their produce, or in promoting increase in carcass weight, may be seen in the full reports constantly appearing of State Colleges in America, Experimental Stations in Germany, in the Rothamstead and Woburn papers, &c., &c., it seems scarcely necessary to go back to 1855 for examples and results, while at the same time modern work is simply ignored.

OUR BOOK SHELF

North Borneo: Explorations and Adventures on the Equator. By the late Frank Hatton; with a Biographical Sketch and Notes by Joseph Hatton. (London: Sampson Low, 1885.)

MR. FRANK HATTON, whose life and labours form the subject of this volume, was the scientific explorer and mineralogist to the North Borneo Company for the magnificent territory now under its sway. After only eighteen months in the island, he was killed by the accidental discharge of his own rifle on his last journey prior to his return to Europe, on the Segama River, whither he had gone in the course of his duties to search for traces of gold. Short as his period of service had been, he had succeeded in exploring a large part of British North Borneo, and the newness of this region as well as the lack of information about the interior will render the second part of this volume, containing Mr. Hatton's own diaries and official reports, of special interest. He was evidently of the stuff of which explorers are made: he had abundant readiness, resource, patience, energy, and a cheery good humour which helped him through many difficulties with native tribes who are all but unknown even to officials of the Company. His first journey from Sandakan, the capital, was to Sequati, for the purpose of reporting on the resources of the petroleum oil shale there: this was succeeded by an adventurous journey up the Labuk River. After arriving at the upper waters of this great stream he struck across the country to the north to Kudat, carrying on explorations in all directions on the way, including a visit to the great mountain of Borneo, Kina Balu. With Kudat as head-quarters, he spent some months around Marudu Bay, at the extreme north point of Borneo, engaged in mineralogical investigations, and discovered samples of copper and copper pyrites, coal, and other minerals. After a short rest, he again left Sandakan, this time going south to the mouth of one of the greatest—perhaps the greatest—of Bornean rivers, the Kinabatangan, which he ascended to the borders of Province Dent. On the way he made several plucky attempts to penetrate south from the course of this river to that of the Segama, but failed on account of the rainy season, and the swamps created in consequence. On the map the lines marking two gallant attempts, which can now be seen to have been almost crowned with success, stop in districts marked "large swamps." Failing in this way to reach the Segama, he was forced to return to the mouth of the Kinabatangan and go down the coast to the Segama, where his mission was to search for gold. The accident which brought his life to an end took place a considerable distance up this river, while he was still ascending it. This, in the barest outline, represents Mr. Hatton's geographical work in Borneo; his mineralogical work was carried on simultaneously. The difficulties of all kinds which he succeeded in overcoming—and they were neither few nor small—are recorded in his diaries and letters. These represent an amount of work rarely done by young men who have barely reached their majority; and this was only the earnest of what he would have accomplished had his life been spared. It is interesting to notice that, according to the latest official reports from North Borneo, gold had been found in small quantities on the Segama River at several places after Hatton's death. The peculiarly painful circumstances under which he died have led to the publication of much of a personal, and perhaps somewhat temporary, interest, but his journals and reports contain solid matter enough on this new British possession to render the volume worth publishing on wider and more general grounds.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On "Seter," "Strandlinjer," or Parallel Roads in Central Norway

I SEND you a copy of a paper from the *Archiv for Mathematik og Naturvidenskab*, Band 10, "Om seter eller strandlinjer i store hoider over havet." As I here describe, as existing in a great part of Central Norway, a phenomenon quite analogous to the famous parallel roads of Lochaber, and also make an attempt towards the solution of the much-discussed question of the origin of these shelves, an abstract will perhaps be of some interest to your readers.

The Norwegian roads I have seen are all situated on the southern side of what geography-books call the Dovrefjeld. In a great many, if not all, of the valleys originating here, especially in Glomdalen, which the railroad from Christiania to Trondhjem follows, and in Foldalen and Rendalen, one to three horizontal shelves are to be seen on both sides, with all the peculiarities described by MacCulloch, &c., from Lochaber. Perhaps, however, the shelves do not slope so much against the valley, and the detritus in it is more worn than in the common till. But there is another more significant difference. Not only at a single point, as noted from Glen Spean, but for several kilometres—*e.g.* in Rendalen—the rock appears as a vertical wall on the inner side, giving the road an aspect exactly like the well-known *strandlinjer* from our coasts. Such rock-shelves alternate in the same road with the more common detrital shelves, just as in the raised beaches near the sea. In Norwegian they are called *sete*, pl. *seter*, viz. "what one sits upon."

Their horizontality requires, as in Lochaber, a water-level as an accompanying factor in their formation. But here in Norway this can certainly not have been the sea, as advocated by Darwin for the roads in Lochaber. Their height is from 657 to 1090 metres, and while the land stood only 180 metres lower than now, the central part of the country was yet covered by a *mer-de-glace* of very considerable bulk, up to 650 metres, which certainly must have destroyed such superficial formations as these detritus roads. Several other arguments may also be brought forward against their marine origin. In Lochaber the coincidence in height of the roads and the cols leading eastward has settled the question that it must have been in local dammed lakes that the shelves originated.

In Norway such a coincidence with cols is not as yet evidently demonstrated, but the elevations already known make it quite probable. The main rivers in the examined tract are the Glommen (the greatest river in Norway) and its affluent, the Folla. The cols at their sources are 664 metres and 950 metres high, and with these heights agree very nearly eight *seter* and three great terraces at different places in Glomdalen, and two *seter* and one terrace in Foldal. This result and some others in accordance with it were mainly obtained by measurements with the aneroid during a single week last summer, and I cannot therefore but take it for granted that a closer examination will find corresponding cols to all *seter*.

The great question here, as in Lochaber, is, What has dammed up these great lakes, which attain a length of 280 kilometres and a depth of more than 300 metres? The difficulties which beset any theory supposing detrital obstacles are still more insurmountable here than in Scotland. About 1000 feet to be removed without traces for every great valley! At the highest *sete* (1090 metres) in the Rondane Mountains it is necessary to build up detritus dams almost all round, as the present environs will not contribute much. Against Agassiz's glacier theory in the form adopted by Jamieson there is advanced the very vigorous objection that a glacier from any neighbouring valley would certainly not be forced up against the opposite side of the valley to the required height when its way up and down the glen was free; besides which the ends of glaciers are generally very much creviced, and there must have been glaciers in all the valleys if in any. To this powerful argument from Milne Home and others there may be added for the Norwegian *seter* that any purely local obstruction in several parallel valleys at about 61° 40′ N.—the southern boundary of the *sete* region—is not very probable.

Where, then, is the required dam to be found? Both in Lochaber and in the *sete* region of Central Norway we meet with the same remarkable glacial phenomenon: the striæ go *upwards* against the drainage. The boulder transport makes this an indisputable fact for a great part of Glomdalen. From this it is a certain deduction that the glacier-shed has not followed the watershed. In Scotland the glacier-marks go higher in the western part than to the east of Lochaber, and as the precipitation is also greater here the originally higher part of the *mer-de-glace* to the west must certainly have persisted for the longest time. By the great ablation the outer margin of the nap shrank from the east coast, gradually retreating up the Great Glen and Strath Spey, &c., towards the corner between the highest mountains in Scotland, where the last rest must have lingered rather long. *This last rest of the inland ice was*, I presume, *that which formed the block*, gradually damming up lakes as it sank below or shrank behind the cols. That it was solid enough as it lay there as a mighty bulk without crevices, which are only caused by movement, can hardly be doubted. The dying rest perhaps sent also relatively slowly-moving glaciers almost to the last straight up the glens in the same direction as the striæ till.

In Norway the last rest of the great inland ice may be supposed to have persisted where the greatest thickness had been, viz. below the glacier-shed. This can be found by the assistance of the southern limit of the north-going striæ, which, as might be expected, coincides very well with the known southern limit of the *seter*, with the exception of a few observations of striæ which a later examination may prove erroneous as to the direction. This line is in Gudbrandsdalen, Österdalen, &c., 200 to 300 km. south of the watershed, and is at a still greater distance in Jemtland, in Sweden. This somewhat surprising result agrees perfectly on closer examination with the orographical and climatological probability, and may also be directly deduced from the glacial physics, but this I cannot here demonstrate to its full extent.

Between this last ice-rest and the watershed now lies this peculiar row of grand glacier lakes, which may be traced up to Swedish Lapland, though as yet no *seter* are known farther north than Jemtland. Everywhere this tract is distinguished from other highland valleys by its astonishing *terraces*. In these, now and then, is found a finely-laminated clay, which elsewhere is confined to the niveau below 500 feet, the old sea-level. This is the case not only in Österdalen and Jemtland, but in Swedish Lapland up to 1400 feet, to the great perplexity of the older geologists of Sweden (such as Erdmann), who, convinced that this clay could only be formed in the sea, were forced to suppose a former, else improbable, sinking of the land to this extent. Its deposition in our great glacial lakes is quite natural.

The conclusions these *seter*—beaches of great height—lead to as to the origin of the *strandlinjer* near the sea, I shall not follow out here. I shall only remark, with respect to the parallel roads of Lochaber, that Prestwich's hypothesis of landslips is untenable as soon as the alternation of rock-shelves and detritus-shelves is recognised. A different origin for the Scottish roads and for our *seter* can hardly be supposed. ANDR. M. HANSEN

University Library, Christiania, December 17, 1885

The New Star near χ' Orionis

THIS star, since December 20, 1885, has been very slowly decreasing in brightness. No trace of nebulosity was observed around it. Its colour on December 19 was red-orange, now it is yellow-orange. Its spectrum is of the 3rd order of Secchi. On December 19 it was very brilliant from the red to the blue, with six to eight brilliant bands decreasing in light to the violet, or the more refrangible side. Now the red of the spectrum is very dark, the yellow less luminous, and the blue more faint than before. The maximum of light is always in the green.

The apparent position of the new star, which I determined on December 20, 1885, 10h. 0m. 17s., Palermo M.T., was

$$\alpha = 5h.\ 49m.\ 4{\cdot}54s.,\ \delta = 20°\ 9'\ 4''{\cdot}3.$$

Palermo Observatory, January 5 A. RICCÒ

Anchor Frosts

MR. J. HANDS, in NATURE of January 14 (p. 246), gives an interesting account of an anchor frost, "the most marked effects of which are," he says, "seen in *comparatively* still water." He adds, "it is said, that water coming upon it (anchor frost) from above will rise in level and flow over it, as over a solid obstruction. This I have not seen myself."

I have seen (and *felt*) this occur on at least one occasion, rather to my discomfort.

When in the Arctic, early one morning in late autumn, I went out to shoot deer for our winter stock of food, and forded a stream at a shallow rapid, dry-shod, in Eskimo boots coming up to the knee. The day, for the season, became very cold, and on my return homewards in the evening I found that the water in the rapid had risen so much that it came fully a foot above the tops of my boots, filling them with water. This increase of depth was wholly caused by the obstruction of a collection of ice-crystals in the form of wet snow, or pulp (through which my feet readily sank), adhering to the stony bottom of the stream. I had to hurry over the mile or two to my fireless tent, rip off my frozen boots and trousers, then jump into my blankets.

The position of this anchor-ice was the very opposite to that described by Mr. Hands, being in a swift but shallow rapid flowing out of a comparatively still deep pool frozen over with a thin coat of ice, but, where open, close above the rapid, having many small ice-crystals floating on and near the surface. The cause of these crystals coming into contact with, and adhering to, the stones at the bottom of the rapid I have given elsewhere, possibly in a previous number of NATURE.

The tenacity of cohesion of this soft mass of wet snow is more clearly indicated by its resisting the great force of a strong rapid, than where it occurs in comparatively still water.

JOHN RAE

4, Addison Gardens, Kensington, W., January 16

The Dover Boring

As the deep boring at Dover is alluded to in the last number of NATURE (p. 255), it may be well to state that a short notice thereof was appended to my paper on the Chatham borings, which was read in abstract at the meeting of the British Association last year, and that a fuller account was included in my paper "On Deep Borings in Kent," read to the Geological Society a few weeks ago (December 2, 1885), and noticed in NATURE of Dec. 24, p. 190. Since then I have got some further information, and specimens of the deeper beds found are now under examination by Mr. J. Sharman, Palæontologist to the Geological Survey. My paper being now in type, though not yet published, there is no need to enter into details, either of this or of a still deeper boring now going on in the same county. Any additional evidence as to the deep-seated rocks of Kent I hope to give in a supplementary paper, if needful, and I hope also shortly to visit the sites of the two borings referred to.

WILLIAM WHITAKER

33, East Park Terrace, Southampton

The Viper and its Young

I WAS very much interested in an account of a viper swallowing its young, given in NATURE a short time ago, and would like to corroborate the statement of Mr. Middleton's correspondent, anent this extraordinary performance, by relating as briefly as possible a little incident of which I was a witness. About the end of August 1885, I was watching a coolie underbushing in the bush on the Demerara River, Demerara, when suddenly a large labaria snake raised his head with open mouth just in front of the coolie. The man struck at it with his cutlass (a knife about twenty inches long), and afterwards assured me that he hit the snake, but I saw the reptile glide off towards the river. I pursued, but without success, the snake having doubtless taken advantage of the river as a means of escape. The coolie, who was a thorough bushman, having been born and brought up in the bush, told me that in all probability there would be another labaria not far off, as they always went in pairs. Next afternoon I heard that William, the coolie, had encountered another labaria, which he had killed. On my going to the place where he was at work, he told me he had buried the snake after cutting off the head. I may here state that a bushman almost invariably buries a snake after killing it, interring the head in a separate grave from the body. This the bushman does because, he says, if any one puts his foot on a snake's skeleton and a bone pierces the skin, the result will be nearly akin to the bite of the snake. This common belief among the sons of the forest has no doubt a good deal of truth in it, especially if a bone be broken in the wound. The interment of the head in a separate grave is merely done as a graphic assurance that the snake can never come to life again. Being curious to know if this labaria was the one I had seen on the previous day, I made William dig the reptile up, and was pleased to find it altogether a much thicker and shorter snake. On recounting his narrow escape from a bite, William vented his spleen by giving the snake's body a hack with his cutlass, when, to my astonishment, out through the wound came seven young ones, varying from five to ten inches in length, as nearly as I could guess. They were all quite lively, although covered with a sort of thin film or saliva. The largest of the brood seemed quite determined on business straight off, so I rapped him over the neck with the back of my knife. We killed the whole lot of them, and William carefully buried them, remarking that the bite of the young was quite as bad as the bite of the old snake. Now these snakes had been buried at a depth of eight or ten inches for from sixteen to eighteen hours, and on liberation did not seem a whit the worse for their entombment. William told me that when he saw the snake first it was lying coiled up fast asleep, and that he had nearly put his foot right on top of it; he, however, cut a stick and killed it before it awoke. We both agreed that from the appearance of the snake she had shed her skin only a few days before. This in all probability was the case, as I found a shed skin about three yards from where she had been killed. The little snakes seemed to me to be inside the stomach, and not in the gullet as Mr. Middleton suggests. The mother also was in a place where there was scarcely any likelihood of her ever having been disturbed to cause her to swallow her brood, and it will be evident that the young did not quickly perish even after the mother was dead. From what has just been stated, would it not be reasonable to advance the theory that the mother snake swallows the young ones after they are hatched, and retains them in her stomach until they attain a development that fits them to take care of themselves, when she either vomits them up, or they wriggle out of her mouth of their own free will?

Not being a naturalist, I am sorry that I cannot give any but the Indian name of this snake, but I will endeavour to find it out if you wish. The labaria must be well enough known to naturalists. A CREOLE

White Blackbirds

A WHITE blackbird lived in our garden a year or so ago for about twelve months. Our gardener had seen it there, or at least one like it, before. I often saw it within a few yards' distance, and it was certainly three parts white, though presenting a mottled appearance. Some neighbours who heard us speak of it said it must be *their* white blackbird, meaning that they had seen it in their gardens. It was shy, but not more so than other blackbirds, and once, during sharp winter weather, came close to the house and into the yard where the poultry feed. I have not seen it for some months, nor heard of it in any other garden. A. S. Mathews

Edgbaston

Curious Phenomenon in Cephalonia

Mr. Ledger (p. 246) need not have had any doubt about the correctness of the information sent him by his friend about currents running from the sea *into* Cephalonia. It is a well-known fact, and the following account of it is from Dr. John Davy's "Ionian Islands," published in 1842, vol. i. 164:—

"The next phenomenon I have to mention is very extraordinary, and apparently contrary to the order of nature: it is the flowing of the water of the sea into the land in currents or rivulets which descend and are lost in the bowels of the earth. This occurs in Cephalonia, about a mile and a half from the town of Argostoli, near the entrance of the harbour, where the shore is composed of freestone, and is low and cavernous, from the action of the waves.

"The descending streams of salt water are four in number; they flow with such rapidity that an enterprising Englishman has erected a grist-mill on one of them with great success. I have been informed that it produces him 300*l*. a year. The flow is constant unless the mouths through which the water enters are obstructed by sea-weed. No noise is produced by the descent of the sea-water, and rarely is any air disengaged; the streams have been watched during earthquakes, and have not been found affected by them. It is stated that fresh-water is perpetually flowing through fissures in the rock from the land in the trench which has been dug for the reception of the mill-wheel, and that, when the sea-water is prevented rushing in, then the water in the trench rises higher by several inches than usual, and the water is brackish to the taste. The phenomenon has been long known to the natives. The little information I have obtained respecting these extraordinary currents I owe to my friend Dr. White, surgeon of the Second Battalion of the Rifle Brigade, collected by him when stationed in the Ionian Islands about 1840."

If Mr. Ledger's friend could give us more information it would be most desirable. I am sorry I had not an opportunity of examining the mill when I was amongst the islands in 1857.

Gateshead, January 17 R. S. Newall

After-Images

Can any reader account for the following interesting phenomenon:—If I close my eyes in the presence of a strong light, so close that not a ray of light can penetrate the lids—in fact, I may generally place my hands firmly over my eyes—I can see pictures of great splendour, more beautiful than any decoration I have ever beheld, sometimes in the form of some splendid architectural design, most elaborately worked out; at others, beautiful landscapes; again, fine geometrical and other designs, as well as every conceivable form of conventional treatment, such as might be applied to carpets, or other floor decorations, iron-work, &c. I would add that all this is seen without any apparent preconceived action of the will, as sometimes, if I close my eyes with the deliberate intention of seeing any particular object, I am disappointed, though not so frequently now as when I first noticed the phenomenon a few years ago. I have sometimes seen designs positively ugly, but as a rule they are most beautiful in form and colour.

I have visited but few grand and noble buildings, and seen but little of beautiful landscapes, as I am only a humble mechanic, but I take great delight in reading descriptions of such buildings and scenes, and am a true lover of sound, substantial, and elaborate workmanship. J. C. S.

PROFESSOR TAIT ON THE PARTITION OF ENERGY BETWEEN TWO SYSTEMS OF COLLIDING SPHERES [1]

Since Clerk-Maxwell published, in 1860, his first grand investigation on the subject, it seems to have been taken for granted, rather than proved, that in a mixture of great numbers of colliding spherical particles of two kinds, the ultimate state would be one in which the average energy of translation is the same for a sphere of either kind. Also that his Corollary, which extends the proposition to a mixture of many systems, is true. Further extensions have been made, the results of which have been considered as irreconcilable with the kinetic theory of gases, at least in its present form.

So far as I am aware, no really *convincing* proof of this theorem has yet been given. Maxwell's first proof is so sketchy, and involves so many inadmissible assumptions, that it cannot be looked on as more than an illustration of a truth which his deep insight had enabled him intuitively to perceive. More recent proofs depend so much on a species of analytical verbiage (under cover of which any amount of assumptions may be tacitly introduced), that, besides being totally unintelligible to any but specialists, they do not bring full conviction even to specialists themselves. What is required is plain, clear statement, and justification of every step about to be taken, such as will commend it to the careful reader, and leave no doubt on his mind as to *what* is about to be done, and *why*; though the mere details of the subsequent necessary calculation may be beyond him. Nothing does greater harm to the average reader, in the way of shaking his belief in the results of an investigation, than the use of analysis instead of, or so as to mask, thought. One may make a mistake in evaluating a definite integral, just as one may make a mistake in adding a column of figures. But when the process of forming the expression to be integrated, or of obtaining the items of the column of figures to be added, is not made fully intelligible, incredulity is very justly aroused, however we may be inclined to trust the special skill of the mere analyst or of the arithmetician in his proper sphere.

In seeking such a convincing proof, I have become from time to time suddenly aware of specially dangerous traps which (some almost obvious, others extremely difficult to detect) abound in this particular region of inquiry. Some of these will appear in what follows. Hence I determined not to be content with anything short of absolutely pointing out the nature of, and the reason for, every step; so that even those who cannot follow the step itself may fully understand *why* it has been taken, and be in a position to judge of its legitimateness.

Limits of space forbid my giving all this in an abstract, so that I must confine myself to a very condensed statement.

For reasons given, we assume the truth of the "error-law" distribution of speeds in any one system of spheres. This will be called the "special" state.

When two systems are mixed, we assume the mixture to be complete; and, on account of the small fraction of the whole number of particles (one from each, or one from either, system), which are at any time in collision, *and of the perfect freedom of collision between any two assigned particles* (this is a point of special importance), we assume that each system, by its internal collisions, maintains its own "special" state. Hence in our investigations the collisions of two particles of the same system need not be attended to. Their sole function has been assigned, and we assume that they accomplish it.

But it is most distinctly to be understood that the above assumptions are absolutely necessary to the prosecution of the inquiry in the manner adopted; and, therefore, to whatever result it may legitimately lead, that result is not to be held as accurate if any of them be departed from. Thus the extensions of Maxwell's Theorem, given by Boltzmann and others, must not be considered as legitimate extensions of that Theorem and its corollaries unless, in the collisions between complex particles, the mechanism of each degree of freedom of any one such particle has perfectly free access for collision with that of the corresponding as well as with that of the non-cor-

[1] Abstract of Paper read to the Royal Society of Edinburgh, January 18. Communicated by permission of the Council.

responding degrees of freedom of the same or of other particles. For instance, Maxwell's Theorem itself is not proved if the spheres of one system have not as perfect freedom for mutual collisions as for collisions with those of the other system. We are not entitled to *assume* that they can then acquire, much less that they can maintain, the "special" state on which the further argument is based. This is one of the traps into which Clerk-Maxwell fell; for he assumed that the result could be deduced from the consequences of a sort of typical impact between two particles, one from each system, moving in directions at right angles to one another, and each having the mean-square speed of its own system.

Let the masses of two impinging spheres, whose coefficient of restitution is unity, be P and Q; and let u and v, measured towards the same parts, be the components of their velocities along the line of centres at impact. Let these become, after impact, u' and v'. Then we have, as in the text-books,

$$P(u'-u) = -\frac{2PQ}{P+Q}(u-v) = -Q(v'-v);$$

which gives, at once,

$$P(u'^2-u^2) = -\frac{4PQ}{(P+Q)^2}(Pu^2-Qv^2-(P-Q)uv)$$
$$= -Q(v'^2-v^2).$$

Each of these equal quantities is double the amount of energy transferred from one sphere to the other.

Now, when kinetic equilibrium has been (at least approximately) arrived at, such transference must (on the average) cease:—so that the equilibrium condition will be

$$P\overline{u^2} - Q\overline{v^2} - (P-Q)\overline{uv} = 0,$$

where the bars indicate average values.

Everything turns on the proper estimation of these averages. For, if the average of uv be taken as zero, we have Clerk-Maxwell's result; provided that $P\overline{u^2}$ and $Q\overline{v^2}$ be proportional to the average energy of a P and a Q respectively. This is a comparatively obvious trap.

But if we consider that collisions are more likely to occur between two particles, having *given* speeds, if they be moving towards opposite parts than if towards the same parts, we see that, on the average, u and v are more likely to have unlike, than like, signs; and therefore that the value of $\overline{uv}$ is negative. It is not so easy to see, beforehand, what sort of changes this consideration may produce in the values of $\overline{u^2}$ and $\overline{v^2}$.

This leads to an inquiry as to the relation between the relative speed of two particles and the probability of their collision, and the formulæ become complicated.

I found, by an *approximate* investigation in which the above consideration was given effect to, that, if the average energies of a P and a Q be called, as usual, $3P\alpha^2/2$ and $3Q\beta^2/2$, we have, nearly,

$$\overline{u^2} = \alpha^2/2, \quad \overline{v^2} = \beta^2/2; \quad \overline{uv} = -e\alpha\beta;$$

where e depends only on the relative magnitudes of α and β. If this were true, it would follow at once that the average energy per sphere would be less for those of greater mass.[1]

But I soon found that at least part of this must be erroneous, because though many of its consequences would require a mere modification of the *mode of stating* certain well-known theorems, others were incompatible with physical principles.

Yet it seemed (and this is a specially good instance of the pitfalls I have alluded to) hardly possible that, as $\overline{uv}$ is certainly negative, we could get $P\alpha^2 - Q\beta^2 = 0$ for the form of the above expression, except when $P = Q$.

When I revised my calculations, dispensing with methods of approximation, I found that, strange as it appears, the average value of $u(u-v)$, the P part of the above expression, depends on α only, and *does not involve* β! Its value is $2\alpha^2/3$, of which

$$\overline{u^2} = \frac{4\alpha^2+3\beta^2}{6(\alpha^2+\beta^2)}\alpha^2 \text{ and } -\overline{uv} = \frac{\alpha^2\beta^2}{6(\alpha^2+\beta^2)}.$$

If the above result, which has been obtained by the evaluation of a number of troublesome definite integrals, be correct, there must be some very direct and simple proof that $\overline{u(u-v)}$ depends on α only.

[1] This conclusion, after I had seen it to be erroneous, and had taken timely precautions, sufficient (as I thought) to prevent its appearing in NATURE, was unfortunately published as a definitely-ascertained fact; without any allusion to the *approximation* on which I had stated it to be based.

REPORT TO THE TRINITY HOUSE ON THE INQUIRY INTO THE RELATIVE MERITS OF ELECTRICITY, GAS, AND OIL AS LIGHTHOUSE ILLUMINANTS

THE Committee appointed by the Trinity House to report on the merits of electricity, gas, and mineral oil as lighthouse illuminants have recently issued a valuable report giving an account of the investigations carried out under their directions, and the conclusions they have arrived at. The Committee consisted of Elder Brethren of the Trinity House. They were assisted by Mr. A. Vernon Harcourt, who was appointed by the Board of Trade to co-operate with the Committee, and by Prof. W. Grylls Adams and Mr. Harold Dixon, in the more purely scientific part of their investigation.

Three temporary lighthouses were erected on the South Foreland, and fitted up for electricity, gas, and mineral oil; the optical arrangements were "multiform" in all three—that is, consisted of several similar sources of light, each with its own condensing lenses, superposed; in the case of the electrical tower there were three superposed lamps, as was also the case with the oil tower: but in the gas tower there were four lamps; the two former were therefore "triform," whereas the latter was a "quadriform" light." Any one lamp in either tower could be lighted independently of the others, so as, for instance, to permit biform electricity to be compared with triform oil and quadriform gas.

The lamps for the electric light, and the magneto-electric machines for working them, were supplied by M. de Meritens; the gas apparatus was that of Mr. Wigham, each burner consisting of 108 jets in concentric rings, of which a part only might be employed; the oil lamps in the third tower during the greater part of the trials were six-wicked Douglass pattern, but burners of this description with seven and eight concentric wicks were also tried at various times during the progress of the experiments.

In addition to the temporary lighthouses, three observing huts and a photometric gallery 380 feet long were erected.

The actual observations that were made may be divided into two classes—eye-estimations, and photometric measurements. The former were made by the Elder Brethren, by officers on board the light-vessels in the neighbourhood, by merchant officers in passing ships, and by the coastguard officers at those stations from which the lights were visible. These eye-observations were of two kinds:—(1) Estimations of the comparative brilliancy of the lights; (2) definite statements as to the various distances at which the lights were visible in hazy or foggy weather.

With reference to observations of the first kind, they were conducted in accordance with regulations issued by the Trinity House Committee: the observers were instructed in filling in the books of forms which were issued to them, to put down in one column the light from the electrical tower as 100 and in the other column the estimated brilliancy of the lights exhibited by the other two towers as compared with it. It seems probable that the recorded numerical values of the relative brilliancy of the lights can only be a very rough approximation, and that the figures can hardly be taken as indicating with any degree of precision how much brighter one or other of the lights was on any particular occasion. This would probably be admitted by all who have any acquaintance with actual photometric measurements, and who therefore know how difficult it is to form any reliable judgment of the relative illumination of two surfaces, even when these surfaces are actually in contact, excepting the relation of equality. In the case of the experimental lights the comparison must have been rendered still more difficult by the fact that what was to be compared was not the comparative illumination of two moderately bright surfaces in close proximity, but the comparative brilliancy of two lights at some distance from each other, their very brightness adding to the difficulty.

Still these estimations are manifestly valuable as setting forth in a clear and unmistakable form that, to the average observer, a particular light appeared the most brilliant; and such seems to have been the way in which they were regarded by the Committee, for on page 21 they state "it will be evident that by mere eye-measurement proportions can only be approximately determined, although the order of superiority may be accepted as proved."

The results of these determinations are set forth in four tables, from which it appears that in clear weather, and in weather that, although not absolutely clear, was not very foggy, there was no question as to the absolute superiority of the electric light over both its competitors, the electric light in the single form having a superiority of more than 30 per cent. assigned to it, as over gas, or oil, in their highest powers (*i.e.* quadriform for gas, and triform for oil); the large-sized gas-burner, with 108 jets, appears to have been slightly superior to the six-wick oil-burner, and consequently the quadriform gas to the triform oil.

The eye-observations of the second kind, those in which the distances at which the lights were visible in foggy weather were recorded, gave much the same result: that the electric light penetrated through the fog to the greatest distance, and that the oil and the gas were about equal in their penetrating power.

These observations also showed that in the case of the electricity the best result was obtained when the currents produced by two or even three machines were sent through a single lamp, and not when each of the lamps was worked by its own special current.

The photometric measurements were carried out by Mr. Dixon, Mr. Harcourt's pentane flame being used as the standard. As is well known, Mr. Harcourt's standard is an air-gas flame which, unlike the so-called standard candles still commonly used for photometric purposes, is not subject to irregular variations in its light-producing powers. Part II. of the Report contains a full account of the standard flame, and the two arrangements for producing it, both of which were in use at the South Foreland. In Mr. Harcourt's original arrangement the air-gas was made and stored in a gas-holder by causing a volume of pentane to diffuse into a known volume of air, and then burning the mixture under certain definite conditions which could be accurately produced at all times. The conditions were such that the flame emitted the same amount of light as an average sperm candle burning under the conditions laid down in the Acts of Parliament which control the quality of the metropolitan gas supply, an amount of light which may differ considerably from that emitted by any single candle.

Mr. Harcourt's pentane lamp was also used; in this arrangement the air-gas is produced as it is required. The lamp is very simple in construction, and the flame is just as constant as in the older form, and as easily regulated, whilst, unlike the older form, the lamp is extremely portable, the whole apparatus not occupying much more space than a packet of candles.

Two kinds of photometer were used: a bar-photometer with a Leeson star disk, and Mr. Harcourt's table-photometer. The latter is a variety of shadow-photometer, and possesses two special advantages:—(1) In common with all shadow-photometers the two sources of light are on the same side of the illuminated surface, and therefore there is less risk of the results being rendered untrustworthy by diffused or accidentally reflected light than when, as in the more commonly employed arrangements, the sources of light are on opposite sides. (2) The comparison being made by altering the size of the flames, and not their distance, the two portions of the illuminated surface do not alter their relative position, and are always in that which is most favourable for comparison, accurate juxtaposition. The difference in colour between the arc light and the pentane rendered it impossible to employ the shadow-photometer for the estimation of the electric light. For these measurements a Leeson star disk was employed, and it was found that reliable measurements could be obtained by placing the disk between the two lights and moving it to and fro until the pattern of the star was equally distinct on either side, although on the two sides the colours of the pattern and the background were reversed.

There was so little difference between the colour of the gas and oil flames and that of the pentane flame, that in the case of these two illuminants measurements could be made both with the star disk and with the shadow-photometer.

Comparisons were made in the photometric shed of the light emitted by the De Meritens electric lamp; the Wigham gas-burners with different numbers of jets up to the maximum of 108; the Douglass Argand gas-burner; the Sugg gas-burner; and the Siemens regenerative gas-burner; and also the six- and seven-wick Douglass oil-burners.

The amount of light emitted by each of the experimental lighthouses was also determined, the observations being made in the huts which had been erected for this purpose at different distances from the towers. At the hut nearest to the towers the light from all the burners could be compared directly with the pentane lamp giving the light of one candle, but at the second hut only the electric light and the higher powers of the gas and oil lights could be directly compared with the pentane lamp; the single gas and oil lights had to be condensed by a lens before accurate measurements of them could be taken; an achromatic lens, lent by the Astronomer-Royal, was used for this purpose. The fraction of the light lost by the absorption and reflection of the lens was experimentally determined and allowed for in the observation.

The general result of a very large number of observations appears to have been that there is but little to choose between oil and gas as far as their illuminating powers are concerned, and that electricity is greatly superior to both.

The experiments brought out one fact of great practical as well as scientific interest—that remarkable changes in the transparency of the air occur without any visible haze or mist. To quote Mr. Dixon's words:—"Invisible clouds seemed to float by, obscuring the lights for a time as they passed across our line of vision. Sometimes the French lights at Calais and Cape Grisnez showed brilliantly, when the photometer at Hut 2 proved that the lights from the experimental towers, only a mile and a quarter away, had lost one-fourth to one-third their power."

With a view of further investigating the fog-penetrating powers of these different lights, the photometer shed was filled with an artificial steam-fog, by means of a pipe brought from the boiler of the engine-house, and the 108-jet Wigham gas-burner, and an electric arc fed by one machine, were pitted against each other, and the distances from which the lights could be seen determined. In all cases the electric arc became visible before the gas flame, as the observers walked up the shed towards the lights, confirming the other eye-observations which have been already mentioned.

The experiments showed also that the electric light suffered a greater proportional loss than either of the two other illuminants when passing through fog or haze, but that, owing to its far greater initial intensity, it nevertheless exceeded the other lights in its penetrating power.

The Committee add to their Report some account of the cost of the three illuminants, from which it appears that there is but little difference in the first cost of the electric and gas systems, the latter being slightly the more costly; but, on the other hand, the annual cost of the gas is estimated at rather less than that of the electricity. The cost of the mineral-oil apparatus is estimated, both for its installation and for its annual maintenance, at about two-thirds that of either gas or electricity.

The general conclusions arrived at by the Committee —conclusions which seem fully borne out by the evidence set forth in the Report—are, that the "electric light, as exhibited in the experimental tower at South Foreland, has proved to be the most powerful light under all conditions of weather, and to have the greatest penetrative power in fog;" that for all practical purposes the gas and oil were equal; and "that for the ordinary necessities of lighthouse illumination, mineral oil is the most suitable and economical illuminant, and that for salient headlands, important landfalls, and places where a very powerful light is required, electricity offers the greatest advantages."

GEOGRAPHICAL EDUCATION

THE Council of the Royal Geographical Society have been making a determined effort during the past eighteen months to improve the position of geography in the education of this country, with special reference to the higher schools and universities. They have collected information as to the position of the subject and the methods used in teaching it in the schools and universities of the leading Continental countries as well as in England, and published the results in the form of a Report, which has attracted considerable attention, and is likely to lead to useful results. In connection with this inquiry the Society has arranged an Exhibition of Appliances in use in Geographical Education at the rooms, 53, Great Marlborough Street, which, since it was opened in the beginning of December, has attracted many visitors of the class for whose special benefit it was intended. Already there are signs that this Exhibition will do real good in at least leading to the multiplication and improvement of the meagre appliances in use in English schools. Nothing could show more strikingly the marked difference in the variety and quality of these appliances in use in English and in Continental schools.

The catalogue of the Exhibition covers 80 large octavo pages. It is arranged in eight divisions—wall-maps, globes, telluria, planetaria, &c., models and relief-maps, geographical and ethnological pictures, atlases, textbooks, miscellaneous. Upwards of 200 wall-maps are shown, while about 100 more have not been hung for want of space. All the leading types of this kind of work are represented on the walls. They are arranged geographically—maps of the world, of Europe, and parts of Europe, and so on. The object aimed at in hanging the maps has been to bring side by side those of the same region by different publishers and in use in different countries, so that visitors may compare the results for themselves. Some of the English work thus shown is certainly good—accurate, carefully executed, and fairly well adapted for its purpose, especially the maps of Stanford and Keith Johnston. The Exhibition, it should be remembered, is purely educational, and therefore the finest cartographical work of our best publishers and our Ordnance Survey must not be looked for; some of this work will compare favourably with the best work of other countries. As a whole, it must be admitted, that English school-maps are far behind those of the leading Continental countries, notably Germany, Austria, Switzerland, and even Italy. We do not seem to be guided by any definite principles in the construction of such maps; our teachers, as a rule, have never seen good school-maps, and the best English cartographers seem to think such work beneath them. We in England seem to cherish the pernicious idea that a school-map should be something quite different in kind from an ordinary map of the best class. In the Continental countries mentioned above, on the other hand, it is recognised that in the case of young people, even more than with men and women, only the very best work should be used, for first impressions are everything. In elementary wall-maps, of course, the minute details of the finest hill-shading and other features would be out of place, but the style and method of the work should be the same, only more generalised. For example, in Austrian schools, maps produced by photography from reliefs are absolutely forbidden on account of the exaggerated impression which they convey. The reliefs are almost necessarily exaggerated in such cases, and the light thrown on them from a particular direction to give picturesque effect; the result as a rule being a misrepresentation of the real configuration of the ground. Maps which attempt to indicate physical features by the use of variety of colour are but little used on the Continent. They do not appeal at all to the eye or help the imagination of the child, and are of no use in helping him to read maps executed in the usual way, which are the maps he must deal with when he grows up to be a man. The use of colour for special features is certainly useful, but then only in advanced classes. For the younger classes in Continental schools one does find it, but almost invariably conjoined with graphic mountain-shading. In the best maps, moreover, when the method is used, often only one, generally not more than two, colours are introduced: green for the lowest levels, tints of brown for the higher levels. In Kiepert's maps, brown alone, in deepening tints according to altitude, is used, just as blue is used after a similar fashion to indicate the varying depths of the sea. And this reminds us of the common practice in the best Continental schools, of always having two maps of the same region for teaching-purposes—one physical and the other political. On the former, always without names and political indications, the physical features are everything, and are boldly brought out; in the latter the physical features are still clear and prominent, but are accompanied by what are known as "political" features. In England one map has usually to serve not only for all grades of classes, but for both physical and political teaching: and as in our best school-maps the physical features are faint and obscured by the glaring colours used for political divisions, they are almost hidden when covered with names and other details.

In the matter of outward appearance, even, our school-maps leave room for great improvement. They, as a whole, cannot be compared as to taste and style with the best Continental maps. The finest of these are either not coloured at all, or the colours are put on faintly and delicately to show political divisions; often only boundary lines are coloured, so that the physical features, which have so much to do with political development, are well shown. The taste of our teachers and map-makers in this matter requires radical reformation; the more glaring and vivid the colouring of wall-maps, the more popular they seem to be. They are enough to ruin the taste of pupils. As examples of what school-maps should be, those of the district of Graz, of the Canton of Zürich, of Switzerland, by Ziegler; of the Alpine countries, by von Haardt, and the same region by Randegger, may be taken as examples in various grades, from the elementary stage upwards. Only the best work should be placed before the pupil from the beginning. There is certainly one good English specimen,—a map of the district around Bradford, by a Bradford teacher, for local geography. The scale is two inches to a mile; there is no overcrowding, and the physical features are bold, careful, accurate, and tasteful, after the best manner of hill-shading. These ought to be the characteristics of all school-maps, which ought to be a picture that the eye of the pupil can at once understand. The elementary principles of hill-shading are easily learned—a few hours' teaching would do; without it, how can the pupil be expected to read his map? It is almost better to have no names on elementary maps; the children should be taught to look for things, not words; the teacher ought to be able to give all the names needed.

Of course, school-maps, especially for the elementary stages, should not be crowded with names and symbols, while at the same time they should be of a character that will lead up to the understanding of the best staff-maps. It is evident from the detailed and beautiful maps from Germany, Austria, and Switzerland, that geography is carried to a much higher stage in these countries than in England. Our maps seem mainly intended to answer the common English conception of geography, that of mere memory-work; the maps without names are "test-maps" to test the memory of the pupils, not physical maps, on which no names should be. Now that local geography is made the starting-point in elementary schools, we want a thoroughly good series of large county maps, with few names, but with the physical features, not in too great detail, but executed with as much care and precision as on a staff map. Local maps ought to be done by teachers themselves, as in the case of the Bradford map referred to. There are several exhibits by London Board-school teachers, creditable to their zeal and industry, but indicative of their want of enlightenment more than of anything else.

One of the best means to teach the pupil to understand a map is to train him to draw maps for himself, either from a model, or, better still, from nature. This is done, we are glad to say, in several schools in this country, notably in Gordon's College, Aberdeen; several specimens of the work thus done in the latter school are shown in the Exhibition. The map must always be the mainstay both of the geographer, of the teacher, and of the pupil, and therefore every means should be taken to train the eye and the understanding to read it as if it were a book. If this Exhibition enlightens our teachers as to the value and characteristics of really good maps, it will have accomplished much.

One of the most striking features of the Exhibition is the number of reliefs of various kinds, from the large model down to the relief-atlas. The finest relief is without doubt that of the Monte Rosa group from Zürich. Here the vertical and horizontal scales are the same; the region embraced is comparatively small, and the scale large—1 : 150,000. The relief itself is by Prof. Imfeld, an eminent Swiss engineer, while the colouring, according to nature, is, we believe, by Prof. Heim, the geologist. For teaching-purposes, for physical geography, its value is great; unfortunately its price is a bar to its general use. The reliefs of a glacier and of a volcanic island are, however, cheap enough, and should be in every school. The model, by Mr. Jordan, showing the contours of the ocean bed around our shores, is also most instructive, though the exaggeration is great—28 times. It has been constructed for the Science and Art Department. Of relief-maps the finest are no doubt the three sections of the Central and Eastern Alps, by Col. Cherubini, in which the vertical scale is only exaggerated twice that of the horizontal. Mdlle. Kleinhans's relief-maps of Europe and France are also fine specimens of such work. There are also German, Italian, and English relief-maps of small size, in which the vertical scale is enormously exaggerated, and which therefore, if used at all, must be used with great caution. Good reliefs are in themselves of great service in giving the pupils a vivid notion of the appearance of a region; but one of their chief uses, in our estimation, is in enabling the pupil to understand the meaning of a map. Therefore besides every relief there ought to be a map of the same region, the one being used to interpret the other. There are several so-called ideal reliefs in the collection, some of them by English Board-school teachers, in which every salient feature on the earth's surface is brought together within an area of a few inches. Such productions ought to be discouraged. Much better to make reliefs of real landscapes, say of the Isle of Wight, or of a limited area around a school; such, for example, as that of the region around Rochester or Kent, by a master in one of the schools there.

One of the most novel features in the Exhibition is the collection of geographical pictures. There are several series of them, the finest, no doubt, being that published by Hölzel, of Vienna, which, in about thirty wall-pictures, shows some of the most characteristic and typical landscapes in various parts of the world. Such pictures add greatly to the living interest, as well as to the instruction, of a lesson in geography. They must above all things be accurate, and therefore large photographs are to be preferred as models to pictures from a purely artistic standpoint. Indeed, photographs themselves, on a large scale, make excellent pictures for geographical purposes, such as those of the Yosemité Valley in the Exhibition, or the well-known photographs of the Alps by Mr. Donkin. Equally serviceable is the series of twelve typical life-size heads of races, edited by Prof. Kirchhoff, of Halle, and sold at a very cheap rate. There are also several pictures of groups of peoples in their native surroundings, some of which are very good.

The Exhibition also contains a considerable collection of globes, including slate globes of various sizes, which we think can be made of great service in the hands of a good teacher. The telluria are mostly of the well-known kind—complicated, and easily put out of order. The simpler such apparatus are, the better; children are apt to contract misleading and erroneous ideas from such things—ideas difficult to eradicate. One of the simplest is exhibited by Stanford: a glass globe with a candle for the sun, with only the earth and moon at the end of the arm. Some means should always be taken to counteract the misleading impressions as to scale conveyed by such instruments; and for this purpose an idea has been borrowed from the arrangement in the Jermyn Street Museum, showing the relative sizes and distances of the sun and planets. A yellow disk, about 6 inches in diameter, is fixed on the wall of one of the rooms, to represent the sun; and 56 feet away are two pellets of wax, $1\frac{1}{2}$ inch apart—one, 1/20 of an inch in diameter, to represent the earth; and the other, 1/60 of an inch, to represent the moon. The whole arrangement is intended to show what would be the relative sizes of sun, earth, and moon, if these were reduced to a scale commensurate with a distance of 56 feet.

Another interesting exhibit is a section of the contrivance devised by Prof. G. H. Darwin, on which he read a paper to the Royal Society some years ago, intended to give a truer representation of the globe than an ordinary projection. It consists of a figure formed of twenty hexagons and twelve pentagons, the projection on which is but very slightly distorted. Of much historical and antiquarian interest are the two large Mollineux globes from the library of the Inner Temple, made in the time of Queen Elizabeth.

There are about 200 atlases shown, like the wall-maps, from various countries—England, Germany, France, Austria, Belgium, Holland, Italy, Switzerland, Denmark, Sweden. Even more than in the wall-maps does the superiority of Continental work to English work come out in these publications. Many of these cheap foreign school-atlases contain some of the finest cartographical work: such as Wettstein's atlas, published in Zürich for about half-a-crown, with about thirty maps of perfect finish. In this, as in some other foreign atlases, are one or two sheets intended to give the pupil an elementary idea of the principal symbols used in cartography—notably of hill-shading. With such a knowledge the pupil will see far more in a really good map than otherwise he could possibly see. Accuracy, beauty, and adaptability to their special purposes are far more frequent characteristics of Continental school-atlases and wall-maps than of English.

Of text-books there are some two or three hundred from all the countries already named, including a few from America. The vice of English text-books is the prominence given to mere memory-work, and the absence of any attempt to show the relations between physical and political geography. Of physical geographies and physiographies we have a few that are not surpassed by those of any country. It is the general text-book that is put together with so little skill and knowledge. In this department foreign countries show far more unsatisfactory work than in the case of maps. Some of the best Continental text-books, especially German, are small, such as that of Kirchhoff, used in all classes of German schools, and in which mere memory-work is reduced to a minimum. In Germany, and indeed in most of the Continental countries represented, the teacher is of far more importance than the text-book, and is to a large extent independent of it; in England everything must be put into the text-book, for few of our teachers know anything of the subject. It is a mistake altogether to write text-books for the youngest classes, those in which elementary notions and local geography are taught; these should depend entirely on the living voice of the teacher, with black-board, compass, simple reliefs, and pictures.

Such are a few of the exhibits brought together in this very useful Exhibition; there can be no doubt that the many teachers who have visited it will have learned a few useful lessons; we hope, for one thing, they will be more exacting as to the character of the maps and other appliances supplied by publishers.

A series of lectures has been arranged in connection with the Exhibition, which so far have been well attended, and been followed by useful discussions. In December two lectures were given, one on the aims and methods of geographical education, the other on appliances. Last Tuesday Mr. Bryce lectured on the historical bearings of geographical education, and next Tuesday Prof. Moseley lectures on its scientific bearings, with Sir Joseph Hooker in the chair. On Saturday next a Conference will be held, in which the whole subject of the position of geographical education will be discussed, with special reference to its place in examinations; Sir Beauchamp Walker, ex-Director of Military Education, will preside at the Conference.

HUNTER'S HOUSE

THE three subjoined drawings are very faithful delineations of some of the portions of John Hunter's house and grounds, at Earl's Court, to which I drew attention in NATURE for Jan. 7. The first drawing supplies the view of the house looking into the meadow, in which view the house is, I believe, nearly the same as it was when Hunter lived in it. The second sketch is that of the Lions' House, or den, situated at the end of the

FIG. 1.—Hunter's House. From the meadow.

FIG. 2.—The Lions' House.

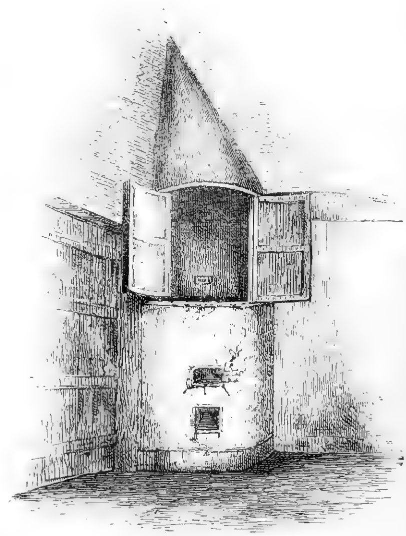


FIG. 3.—The Copper.

meadow at the back and to the right of the house, but quite visible from the windows. The Lions' House, as will be seen, is a raised mound of earth. The earth rests upon an arched structure, which, at the time of my last visit, was in excellent condition, although ever since Hunter's time it has been a cow-house, and has done nearly a century of useful service. At the top of the mound there is a little wall, of a circular shape, inclosing a small open space. The third sketch illustrates the famous copper in which the Irish giant was boiled to a skeleton. The space above the copper up to the flue from the roof is covered in, but two doors open in front above the mouth of the copper. The whole of this structure has remained in good preservation.

The sketches are selected for NATURE from views which Bertram Richardson has taken during the last autumn, as part of a series of homes and birthplaces of illustrious men. B. W. RICHARDSON

THE METEOR SHOWER AT THE MAURITIUS

ON the evening of Friday, the 27th of November last, a great shower of meteors was observed at Mauritius.

The weather was cloudy and the sky often overcast, but from the accounts which I have received from different parts of the island it would appear that the shower lasted from at least 7 p.m. till midnight.

At Reduit, about 900 feet above the sea-level, where the sky was clearer than at the Observatory, His Excellency Sir J. Pope Hennessey, saw many bright meteors, which at first appeared to travel from N.W. to S.W., and a crackling noise was heard.

Looking on from 8 to 8.30 p.m. at Beau Bassin, Col. Stewart, R.E., saw about twenty meteors per minute, apparently travelling from N.W. to S.W.

About 7 p.m. several members of the Rev. Mr. McIrvine's family, happening to turn their faces towards the north, immediately observed a number of bright meteors, and in a short time they counted 200. Later on, Mr. McIrvine and two other observers counted 700 in three-quarters of an hour, although the sky was much overcast to the west and north and slightly to the east. Between 8.45 and 9 p.m. Mr. McIrvine and Mr. Hollway counted 150 passing along a narrow clear space just above Orion. From 9 till midnight the sky was several times quite overcast, and as the clouds cleared away the meteors could be seen faintly through the mist, gliding along ghost-like. Between 11.34 and 11.50 Mr. McIrvine counted 160, which appeared in an unclouded space between Orion and the zenith. The sky was clouded towards the north the whole evening, and the meteors seemed to come from under that cloud, and, with few exceptions, they all travelled towards the south. Occasionally, a small one, needle-like, darted now towards the S.E., now towards the S.W., but none were seen going back, or even so far aside as east or west. Most of the meteors were small and needle-like, of a whitish colour, with paths extending from 5° to 40°, although some seemed to appear and vanish instantly without perceptible movement. The meteors moved quickly, not unlike arrows approaching the target in an archery competition. The very largest travelled slowly across 30° to 50°, and some of them were blue, some white, some red. Many of them looked like comets, and every now and then it was noticed that the head—which was very distinct—suddenly vanished, while the double-winged train (20° to 40°, or more, in length) still moved on.

At Vacoas, at an altitude of nearly 1300 feet, the Hon. Mr. Elliott first saw the meteors at 7.15, and he counted 791 from 8.35 to 9.15. The principal direction seemed to be from N.N.E. to S.S.W. The most brilliant passed near Venus.

In the same part of the island, Mr. Freeland observed a great many meteors between 10.15 and 11.30. The shower was not constant, but at short intervals, and the meteors travelled from north to south.

At the Observatory, in the northern part of the island, the weather was cloudy, and the sky generally entirely overcast. At 8.20 p.m. several meteors were seen coming from the northward. Between 9.1 and 9.9 Mr. Bell and myself, with two other observers, counted not less than 204, though the greater part of the sky was overcast, and not less than 173 between 9.9 and 9.16. Between 9.26 and 10.40, the sky was completely overcast. From 10.40 to 10.50 glimpses of Aries, Taurus, and Orion were got, and in that interval six large meteors with long trains passed towards the south-eastward between α Arietis and the Pleiades, and three more between 0.30 and 0.40 a.m. The sky then began to clear up towards the N.W. and north, and I kept up watch till 1.15 a.m., but no more meteors were seen.

I did not see the similar shower that was observed here in 1872; but from what I saw between 9.1 and 9.16 p.m. on the 27th of November last, during which time Andromeda, Aries, Taurus, Orion, &c., were visible, it is certain that the radiant-point was near γ Andromedæ, or that there was a radiant-space around that star.

The meteors shot to the southward, south-eastward, and south-westward, some of the largest with trains of 20° to 40° in length, disappearing to the southward behind the Port Louis and Pieterboth mountains, and others bursting with great brilliancy near Venus, Fomalhaut, α Gruis, &c.

On referring to the account given of the shower of November 27, 1872, by Mr. C. Bruce and Mr. Ed. Newton, it would appear that the radiant-point was the same on both occasions, or very nearly so, but that the maximum intensity of the shower was earlier this year than in 1872. C. MELDRUM

Mauritius, December 22, 1885

NOTES

THE meeting of the British Association to be held at Birmingham, beginning on Wednesday, September 1, will derive more than usual interest and importance from the exhibition of local manufactures which is to be held in connection with it. The Exhibition will be on a very much larger scale and of a much more popular and attractive character than has ever been attempted before. It is to be an Exhibition illustrative of products and processes connected with the manufacturing districts of Birmingham and the surrounding district within a radius of fifteen miles, which will include the whole of the Black Country, the nail district, and other towns where manufactures are carried on. The Exhibition will be on a very complete scale, and will embrace as nearly as possible all the industries of the district, which will include the following:—Engineering, hardware, heating and lighting, arms and ammunition, jewelry, glass and pottery, stationery, leather, furniture and decoration, and a miscellaneous class, including scientific and musical instruments. The special feature of the undertaking will be that in every trade represented processes will be either completely shown or fully indicated. Workmen will be seen engaged in carrying out most interesting or difficult operations connected with various industries. The Exhibition will be opened on August 26, and close on October 1, three weeks after the termination of the visit of the Association.

A PROJECT has been started in Berlin to establish there an Anthropological Exhibition, which will do with regard to the races of men what zoological gardens do with regard to animals. In the Exhibition or garden it is intended that representatives of various races shall permanently reside, while of such races as cannot stand the cold of the climate representatives will be brought to Germany to reside there during the summer. An

Ethnological Museum is to be established in connection with the Exhibition, which is said to have the support of several capitalists. Possibly the recent success in Berlin and London of Japanese and Indian villages has led to this project, which, however, is a far more difficult undertaking, but which, if carried out, would prove of great public interest. A good many years ago, at the Crystal Palace, an attempt to represent various peoples and their habits by means of models was commenced, but it was never carried very far. Some of these models are still to be seen at the south-west corner of the main building.

THE annual meeting of the Association for the Improvement of Geometrical Teaching was held at University College, Gower Street, on Friday, January 15, when certain additions to the rules were carried and twenty new members (including three honorary members) were elected. At the afternoon sitting, the President (R. B. Hayward, F.R.S., Harrow) read a paper on the "Correlation of the Different Branches of Elementary Mathematics." A discussion on the paper was commenced by the Rev. G. Richardson (Winchester), in which the Chairman (R. Levett, Birmingham), Profs. Carey Foster, Hudson, and Minchin, Messrs. A. J. Ellis, Heppel, Walters (Dover College), and the Rev. J. B. Lock (late of Eton) took part. We hope to notice the paper when the Report of the Association has been printed.

ON December 31 last, Mr. G. J. Symons completed the twenty-fifth year of his work in connection with "British Rainfall," and it has been thought a good opportunity for presenting him with a pecuniary testimonial, to which all observers of rainfall are invited to subscribe. The Committee have already published a first list of subscribers, and as they are anxious to present Mr. Symons with the testimonial as early in the year as possible, all observers who intend to subscribe are requested to communicate with the treasurer, Rev. Clifford Malden, St. Lawrence Rectory, near Ventnor, Isle of Wight.

AS examples of tropical rainfall, it may interest our readers to learn that during the present rainy season in Jamaica, which has succeeded a period of serious drought, there was recorded at the Government Cinchona Plantations on December 21 last a fall of 11·80 inches in twenty-four hours, while the gauge, the readings of which are taken at 7 a.m. daily, was full and overflowing. On the crest of the Blue Mountain range, on the same plantations, the record was 31·50 inches for one week, of which period three days were fine.

THE following alteration has been made in the arrangements for the Friday evening meetings at the Royal Institution before Easter:—Prof. W. H. Flower, F.R.S., will give a discourse on Friday, February 19, on "The Wings of Birds," instead of Prof. W. K. Parker, F.R.S., on "Birds, their Structure, Classification, and Origin."

THE thirty-ninth annual general meeting of the Institution of Mechanical Engineers will be held on Thursday, February 4, and Friday, February 5, at 25, Great George Street, Westminster. The chair will be taken by the President, Mr. Jeremiah Head, at 7.30 p.m. on each evening. The following papers will be read and discussed, as far as time permits:—Description of an autographic test-recording apparatus, by Mr. J. Hartley Wicksteed, of Leeds; description of tensile tests of iron and steel bars, by the late Mr. Peter D. Bennett, of Tipton; description of a hydraulic buffer-stop for railways, by Mr. Alfred A. Langley, of Derby; on the distribution of the wheel load in cycles, by Mr. J. Alfred Griffiths, of Coventry.

THE Council of the Society of Telegraph Engineers and Electricians are at present engaged in considering a proposal brought before them by Prof. J. A. Fleming, and having for its object the establishment of a National Electric Standardising Laboratory.

THE third Electrical Exhibition at St. Petersburg was opened on January 1 by Prince Michael Nikolaievitch. It is held in the buildings of the Pedagogical Museum, and is said to be the largest ever held. The telephonic department forms a special attraction.

A GERMAN edition of Prof. R. S. Ball's researches on "Theoretical Dynamics" is in the press. The volume will contain the "Theory of Screws," published in 1876, and the papers subsequently read to the Royal Irish Academy. The whole has been edited and translated by Dr. Harry Gravelius, of Berlin, who has occasionally added developments necessary for continuity and completeness.

A PROPOSITION has been made in Ceylon for the systematic observation of the singular migration of butterflies in that island. Despite occasional references in the local press, nothing has yet been done towards compiling and editing a scientific and comprehensive record of annual observations. It is proposed therefore that volunteers should watch for the migration, and send a postcard bulletin to the editor of the records, noticing date, direction of flight, direction of wind, the weather, and the species. For the last purpose amateur observers are to send one specimen of each species noticed, in order to insure scientific accuracy. A competent naturalist is stated to have offered to revise, assort, and edit all such notices once or twice a year, and publish a periodical report of progress. The annual summary will appear in the *Taprobanian Magazine*, the first number of which we recently noticed.

WITH the great spread of education throughout England during the past sixteen years it is extraordinary how little here compared with the United States the work of the schools has been supplemented by those "universities of the people," free libraries. No doubt the costliness of working one in a community where the produce of the penny rate does not amount to 500*l.* a year is a great difficulty, as such a sum is absorbed in the ordinary working expenses of rent, attendance, gas, and newspapers. We would call attention to the success of a method of supplementing an insufficient income clearly shown by a catalogue we have received from the Coventry Free Library. For many years its rate brought in little more than paid the above expenses. A club was then established consisting at first of a few assiduous readers who selected their books, kept them for their own use for six months, and then sold them to the Free Library at one quarter of published price. To the club the advantages were that the Free Library, open at all hours, being their depot, they had scarcely any working expenses, the books all remained permanently within their reach, and yet, instead of having to purchase at the end of the year books which they did not want, one-third of the amount of their subscription was returned to them for further purchases of books. The advantage to the Library is shown by the present catalogue, from which we learn that the still-increasing list of members has now reached 172, and, accordingly, that it is passing more than 1200 works yearly into the Library at an expense of over 200*l.* per annum. There is an increase of over 11,000 works in the Library since the last catalogue was printed; and a larger proportion of them than usual in a Free Library are high-class and costly books derived from this source, which must make the Library the resort of the most studious and best educated readers of the city.

IN the last number of *Naturen*, Herr Karl Hesselberg closes his series of interesting papers on the climate of Norway. The small number of systematically organised meteorological stations in the country has necessarily interfered with the acquisition of all the data required to formulate a comprehensive and scientific theory of the Norwegian climate. As a contribution, however, to our meteorological knowledge, the author's numerous tables of the frequency and periodicity of certain weather phenomena in various parts of the country are of considerable value, while special and novel interest attaches to his observations of various anomalous meteorological conditions, such, for instance, as the occurrence of a maximum rainfall at points far inland and unconnected with the sea, which he refers to the influence of cyclonic agencies.

M. PAUL BERT, who has been gazetted Resident-General in Tonquin and Annam, has been interviewed by several correspondents, and has written articles indicating that he will endeavour to promote the interests of science. He is desirous of establishing a "Tonquin Institute," some organisation similar to the Institut d'Égypte, which was created by Bonaparte in 1798. Although nothing definite has been stated, these declarations have created some sensation in the French scientific world.

MORE than usual seismic activity is reported from Central and South America. On the 18th ult. the town of Amatitlan, in Guatemala, was nearly destroyed by an earthquake, there being altogether 131 shocks. In other parts of Central America shocks of earthquake have occurred. It is reported from Guayaquil that symptoms of earthquake have been observed at Chimbo, in Ecuador, coincident with a renewed eruption of the volcano of Cotopaxi. The previous eruption of this mountain was lately referred to here. The Ecuador volcano, Tunqurqua, is in a state of violent eruption, being evidently, it is stated, in sympathy with Cotopaxi.

AN influential Committee has been formed for the purpose of raising a permanent record of Dr. Redwood's services to chemistry in its relation to medicine and pharmacy. It is proposed to found a "Redwood Scholarship" in connection with the Pharmaceutical Society, which has for more than half a century been the principal scene of Dr. Redwood's labours. Subscriptions should be sent to the Honorary Secretary, Prof. Dunstan, 17, Bloomsbury Square, London, W.C.

MR. LANGTON COLE, of Loughrigg, Sutton, Surrey, writes to the *Times* that a remarkable meteor was seen there on the 16th at 5.9 p.m. in bright twilight. Its apparent course, which was marked by a continuous and brilliant train, was from the zenith to a point due east, about 15° above the horizon. It was brighter than Venus, and the diameter of its head seemed about one-sixth of that of the moon. A Wimbledon correspondent also writes that he witnessed the fall of a meteorite, apparently a few miles east-north-east of Rickmansworth Church, at about 5.5 p.m. on the same day. The "nucleus" was comparatively small, and showed vividly the colours of the rainbow. The tail was not the long fleecy fiery thing one sometimes sees in such cases, but a well-defined oval, about the apparent size of the moon in her present phase, and as bright and creamy as molten silver.

THE fourth of Prof. Terrien de Lacouperie's course of lectures on Indo-Chinese philology will be delivered on Wednesday, the 27th inst., at University College. The subject will be "The Languages of Thibet and Burmah."

THE last number of the *Folk-Lore Journal* (vol. iii., part 4) contains some Chilian popular tales collected *vivâ voce* in the country, and translated by Mr. Moore. Rev. Walter Gregor, in a paper on "Some Folk-Lore of the Sea," describes the superstitions and sayings of the fishing population on the north-east coast of Scotland. Some of the former are very curious survivals; while other customs appear to have for their object the drinking of whisky at some one else's expense. Mr. Christopher Gardner, of the Consular Service in China, gives a number of Mongolian folk-tales, translated apparently from M. Potanin's work on North-Western Mongolia; and Dr. Morris continues his folk-tales of India, the present instalment being the most important contribution to the number.

WE regret to learn of the death of Mr. J. B. Jeaffreson, M.R.C.S., on the 12th inst. Till lately President of the Highbury Microscopical Society, he was well known in the North of London as a diligent worker with the microscope in biological research.

THE Berlin Academy of Sciences has granted 3000 marks (150*l.*) to Lieut. Quedenfeldt for an exploring tour to the Atlas Mountains. Lieut. Quedenfeldt will principally study the natural history of the district.

AT the forthcoming Indian and Colonial Exhibition it is intended not only to display turtles in tanks, but to hatch them from the ova. It is exceedingly interesting to watch the manœuvres of the infant turtles on being liberated from the ova, and this is sure to prove one of the sights of the Exhibition. A spacious conservatory is being specially erected for the purpose, in which the turtles will be surrounded by every detail of their natural existence.

A STRIKING evidence of the fertility of the sea-trout (*S. trutta*) has been revealed at the South Kensington Aquarium, where several have been artificially spawned with great success. We believe this is the first time on record that this species has been made to yield ova under similar circumstances. The fish in question had been kept in captivity with other species of Salmonidæ for three years, and therefore had never visited the sea, as is their wont, but notwithstanding the check thus placed upon their natural instincts, their condition has not been in the least impaired, neither have their productive functions become disorganised. The operations of the inhabitants of the Salmonidæ tank at the Aquarium are very interesting to watch at this season of the year, especially the manner in which the fish pair with opposite species—for instance, the fontinalis with the common trout, [the sea-trout with the *Gilleroo* trout, &c. In captivity, fish yield their ova much later than they do when in a wild state; but of every thirty subjected to artificial existence there is, upon an average, only one barren fish amongst them.

AT the Lochbuy Fishery, Isle of Mull, the property of the Maclaine of Lochbuy, large quantities of ova of salmon and sea-trout are being incubated, consignments having been imported from abroad. The extensive waters on the Lochbuy estate, which were formerly destitute of fish, now teem with life, the result of systematic pisciculture. The proprietor has been most successful in spawning from the fish captured in the rivers of the property.

THE papers in the last number (No. 3) of the *Proceedings* of the Chester Society of Natural Science are of a more than usually high order, which is not-surprising when the names of some of the authors appear. Prof. McKenny Hughes has a paper, with elaborate illustrations, on the geology of the Vale of Clwyd; Mr. Aubrey Strahan writes on the denudations of North Wales; while Prof. Judd suggests as a problem for Cheshire geologists the investigation of a patch of secondary strata between Audlem and Wem, not far from Chester,—the points suggested are the exact extent and limits of this outlier, the relations of the Lias to the surrounding strata, and the nature, thickness, and fossil contents of the strata of which it is composed. A committee of of the Society has been appointed to examine into the subject. Mr. Mackintosh describes certain traces of an interglacial land-surface near Crewe. Mr. Walker has three papers—one on the climatic causes affecting the distribution of Lepidoptera in Great Britain, the second on the Macrolepidoptera of the Chester district, which is a long and careful list; and his third paper is on the climate of the Chester district considered in its relation to fruit-growing. Dr. Stolberforth describes the special forms of microscopic life found by surface dredging in the estuary of the Dee. Mr. Ruddy gives a list of the Caradoc or Bala fossils found in the neighbourhood of Bala, and Mr. Siddall writes on the American waterweed (*Anacharis Alsinastrum*, Bab.), its structure and habit, and adds some notes on its introduction into this country, the causes affecting its rapid spread at first, and present apparent diminution. Mr. Shrubsole has three short papers—one a list of the land and freshwater shells of the Chester district, a second on the *Glauconome disticha* from the Bala beds at Glyn Ceiriog, and the third on the occurrence of *Calcisphæra* (Williamson) in the Eglwyseg rocks near Llangollen. It will be noticed that these fifteen papers, with two exceptions, refer solely to the district in which the Society works, and that they refer to its geology (including palæontology), meteorology, and several departments of its natural history. The Society is to be congratulated on the thoroughness and comprehensiveness of its work for the past year.

ACCORDING to the *Colonies and India* the Winnipeg Historical Society has suggested to the Canadian Government that a scientific investigation be made into the remarkable ancient mounds recently found in the Canadian North-West, and the suggestion has been warmly commended in the Canadian press. It is pointed out that these mounds are rapidly disappearing under the ploughshares of the farmer, and with them will go the best means of settling the problem whether the mound-builders crossed from Asia and passed down the river valley to the central portions of the continent, or whether their migrations were from south to north.

THE recent attempts to cultivate the tea-plant in the neighbourhood of Messina have been very successful. Similar experiments had been made some years ago without giving any satisfactory results.

AN International Exhibition, similar to that held at Antwerp last year, is planned by the city of Geneva for 1887.

THE Provincial Diet at Salzburg has issued a law interdicting the sale of Edelweiss-plants with roots. The Tyrol Diet has also asked for Government regulation of the trade in these plants.

MR. JAMES GRIEG, of the Museum of Bergen, informs *Naturen* that in the course of last summer a male specimen of *Palinurus vulgaris* was taken in a lobster pot at Manger. This, as far as is known, is the first time that this crustacean has appeared as far north as the Norwegian coasts.

THE following new books and new editions have been received by us since January 1:—"A Tangled Tale," by L. Carroll (Macmillan and Co.); "East Anglian Earthquake of 1884," by R. Meldola and W. White (Macmillan and Co.); "Osteology of the Mammalia," 3rd edition, by W. H. Flower (Macmillan and Co.); "A Brief Text-Book of Political Economy," by F. A. Walker (Macmillan and Co.); "A Treatise on Colours and Pigments," 2nd edition, by J. S. Taylor (Winsor and Newton); "Catalogue of the Coventry Free Library"; "Practical Bacteriology," by E. M. Crookshank (Lewis); "Key to Todhunter's Mensuration for Beginners," by the Rev. Fr. L. McCarthy (Macmillan and Co.); "Catalogue of Fossil Mammalia," British Museum, part 2, by R. Lydekker; "Geology," vol. i., by Prof. Prestwich (Clarendon Press); "Annuaire de l'Académie Royale de Belgique" (Hayez, Bruxelles); "The Rotifera; or, Wheel Animalcules," by Hudson and Gosse (Longmans); "Light," 4th edition, by Prof. Tyndall (Longmans); "Year-Book of Pharmacy, 1885" (Churchill).

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Messrs. Phillips Bros.; a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, presented by Mrs. Sinclair; a Ring-tailed Coati (*Nasua rufa* ♂) from South America, presented by Mr. C. E. Dashwood; a Northern Mocking Bird (*Mimus polyglottus*) from North America, presented by Mr. F. Green; a Jackal Buzzard (*Buteo jacal*) from South Africa, presented by the Rev. C. W. H. Reynolds; a Jay (*Garrulus glandarius*), British, presented by Mr. E. R. Collins; three Hoary Snakes (*Coronella cana*) from Constantia, South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a White-throated Capuchin (*Cebus hypoleucus* ♀) from Central America, deposited; four Cirl Buntings (*Emberiza cirlus*), two Pied Wagtails (*Motacilla lugubris*), British, purchased; a Vulpine Phalanger (*Phalangista vulpina*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET BROOKS.—Dr. H. Oppenheim has computed the following elements and ephemeris for Comet Brooks:—

T = 1885 Nov. 24·7806 Berlin M.T.

$$\left.\begin{aligned}\pi &= 296^\circ\ 38'\ 45''\\ \Omega &= 262\ \ 1\ 48\\ i &= 42\ 25\ 11\end{aligned}\right\}\text{ Mean Eq. 1886·0.}$$

$$\log q = 0{\cdot}03012$$

Error of the middle place (o – C).

$$d\lambda = -4'' \qquad d\beta = -2''$$

Ephemeris for Berlin Midnight

1886	App. R.A. h. m. s.	App. Decl. ° ′		Brightness
Jan. 22	21 35 11	+15 21·0	0·3115	0·59
24	21 42 32	+16 7·0		
26	21 49 50	+16 51·9	0·3203	0·54
28	21 57 4	+17 35·7		
30	22 4 14	+18 18·5	0·3295	0·49

The brightness on December 28 is taken as unity.

This comet was independently discovered by Mr. E. E. Barnard, of Vanderbilt University, Nashville, Tennessee, on December 27, the night after its discovery by Mr. Brooks.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 24-30

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 24

Sun rises, 7h. 52m.; souths, 12h. 12m. 22·5s.; sets, 16h. 33m.; decl. on meridian, 19° 9′ S.: Sidereal Time at Sunset, 0h. 49m.

Moon (at Last Quarter on Jan. 27) rises, 21h. 13m.*; souths, 3h. 39m.; sets, 9h. 53m.; decl. on meridian, 1° 53′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 55	10 50	14 45	23 10 S.
Venus	8 39	14 17	19 55	5 5 S.
Mars	21 6*	3 35	10 4	5 9 N.
Jupiter	22 12*	4 11	10 10	1 4 S.
Saturn	13 45	21 55	6 5*	22 38 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultation of Star by the Moon

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
24	B.A.C. 4043	6½	3 40	4 40	100 222

Jan.	h.	
24	18	Jupiter in conjunction with and 0° 17′ south of the Moon.
26	16	Venus stationary.
26	21	Mars stationary.
30	6	Mercury at greatest distance from the Sun.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m	
U Cephei	0 52·2 ...	81 16 N. ...	Jan. 27,	23 21	*m*
λ Tauri	3 54·4 ...	12 10 N. ...	,, 26,	4 21	*m*
			,, 29,	3 14	*m*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 29,	0 46	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 26,	20 49	*m*
U Ophiuchi ...	17 10·8 ...	1 20 N. ...	,, 24,	11 42	*m*
		and at intervals of		20 8	
δ Cephei	22 24·9 ...	57 50 N. ...	Jan. 28,	5 0	*m*
			,, 29,	19 0	*M*

M signifies maximum ; *m* minimum.

Meteor Showers

One of the minor periodical showers with radiant at R.A. 135°, Decl. 40° N., shows a maximum during the present week. Occasionally large meteors are observed from this radiant. Meteors from a radiant about R.A. 180°, Decl. 35° N., should also be looked for.

GEOGRAPHICAL NOTES

M. DE WOGAN, who has been searching in a small canoe for the true source of the Danube, communicates the result in a recent *Bulletin* of the Paris Geographical Society (Nos. 19 and 20). The story that it takes its rise in the gardens of the Prince of Fürstenburg at Donaueschingen, where a monument recording the fact is erected, is, he says, a fable. The Danube, he has found, is formed by the union of two small streams, the Brig, or Brigach, which takes its rise at Saint-Georges, to the north of the Mountain Tryberg, at about a mile from the source of the Neckar, and the Breg, or Bregach, which rises at St. Martin, to the west of Tryberg, and twenty miles from Donaueschingen, where both streams unite. M. Wogan, who has explored these streams and their tributaries, criticises and corrects the statements of MM. Réclus and Saint-Martin in their geographical works on this subject. M. Charles Rabot, in the same *Bulletin* describes a journey made during the last autumn in the peninsula of Kola, in Russian Lapland, a region which is largely a blank on our maps. In August M. Rabot traversed the peninsula twice, from north to south, from the Arctic Ocean to the White Sea. He describes it as excessively monotonous, covered by forests, with many large lakes, or rather marshes. On the eastern shore of Lake Imandra there is a range of mountains, called Umbdek, which reaches an altitude of a thousand metres, and which is the highest elevation in European Russia, except the Caucasus. These are a picture of savage desolation. He has come to the conclusion that the western part of Russian Lapland is far from being flat, as generally represented on the maps. Between the White Sea and the ocean there are three ranges of mountains separated by large depressions covered with forests, marshes, and lakes. M. Rabot concludes with some observations on the inhabitants—Russian Lapps and Samoyedes.

MR. CYRIL HAVILAND, of Sydney, in a letter in the *Times*, points out how little is really known in a scientific sense, of the islands of the Southern Pacific and of parts of the Australian coasts. Eleven of Her Majesty's vessels are at present in Sydney; they cruise frequently in these seas, but, says Mr. Haviland, no one is any the wiser. He thinks that these ships, and others of the Royal Navy suited for the purpose, should, as far as possible, be utilised by placing on board one or more specialists in the various fields of science, with the appliances necessary to enable them to prosecute their researches. He says that had only one professed naturalist been borne on the books of the *Nelson* or the *Diomed* during their stay on the Australian station, much light might have been thrown on many problems, for the seas and islands abound with undiscovered species. The suggestion is certainly a good one, for there must be many occasions when good scientific work could be done in the vessels of our Navy without in the smallest degree interfering with the object of the cruise or the discipline of the ship. How much may be done in that way by an officer of scientific attainments even in the midst of his professional work, is shown by the instance of Dr. Guppy, whose numerous communications in our own columns and elsewhere have made his name well known in the world of science.

AMONGST the articles in the current number of the *Proceedings* of the Royal Geographical Society is one by Mr. Ravenstein on bathy-hypsographical maps, with special reference to a combination of the Ordnance and Admiralty Maps. The leading features of maps such as Mr. Ravenstein suggests are that all heights and depths would be referred to one and the same datum-level; the features of the ground would be shown by means of horizontal contours, which would enable the compiler to limit himself to the introduction of a comparatively small number of carefully-selected figures; the intervals between the contours would be tinted to bring out the relief of the ground; the line along which land and water meet at ordinary spring tides would be marked; the foreshore and all sand-banks which uncover would be clearly indicated as on ordinary Admiralty Charts; roads, railways, and other features calculated to obscure the physical features of the ground would be omitted. A physical outline map of this character could be utilised for illustrating the hydrographical, geological, and other features of the country. Another important paper is Mr. Delmar Morgan's translation of the notes of M. Kossiakof, the military topographer who accompanied Dr. Regel on his journey in 1882 in Karateghin and Darwaz, on the borders of Chinese Turkestan and Afghanistan.

A LONG letter has just been received from Mr. H. O. Forbes, who, it will be remembered, left England in the beginning of last year, for the exploration of the interior of New Guinea. Mr. Forbes arrived at Port Moresby on August 28 last, and on September 2 started for Sogeré, in the interior, to prospect. He had a pleasant trip, saw the lie of the land, and the people—taking to them and they to him—and returned to Port Moresby to pick up his men and his baggage to start for the Owen Stanley Range in true earnest. On October 1 Sogeré was reached again. Within a week houses were erected for Mr. Forbes, his white companions, his men, and his stores; and soon after everything had been brought from Port Moresby and housed. Returning to the Astrolabe Range with Mr. Hennessy, Mr. Forbes completed his survey. On his return to Sogeré he found everything in shape, and began work at once with the help of his companions, collecting in the fine forest near the village, taking observations, and laying plans for the future. Mr. Forbes had made up his mind that it would be impossible to accomplish the ascent of the Owen Stanley Range this season, one of the results of the delay caused by the loss of his baggage. In the end of April, when the wet season is passing over, the attempt will be made. He had sent his Malay servant, Lopez, to camp out in search of a rare bird of paradise; and it speaks well, he says, for the quiet of the country that he can go off alone to a distant village where his language is unknown. On his way to the coast for supplies Mr. Forbes met Sir Peter Scratchley, who went on to Sogeré with Mr. Forbes, and expressed himself charmed with the house and the work already done, as well as with the good relations established with the natives. Mr. Forbes went back with Sir Peter Scratchley in order to accompany the latter to the north coast and Huon Gulf. Without additional funds it is very doubtful if he will be able to accomplish all he has planned.

THE current number of Dr. Umlauft's *Rundschau* contains an article on the geographical knowledge of the Alps in early times, the present instalment dealing with the Roman period. Other articles describe the Samoans and their customs; a cruise in the Straits of Magellan; while Herr Gavazzi discusses the orography of "the Croatian Mesopotamia," as he calls the district lying between the Drave and the Save. There are also some interesting statistics relating to the populations of German towns, schools in Finland, &c., but the most generally interesting of these are the statistics relative to the journeys of the various travellers who have crossed Africa from time to time. Dr. Livingstone crossed from St. Paul de Loanda to Quilimane, a distance of about 4000 kilometres, in twenty months; Commander Cameron from Bagamoyo to Catombela, 6000 kilometres, in thirty-two months; Mr. Stanley from Bagamoyo to Boma, 11,500 kilometres, in thirty-three months; Major Serpa Pinto from Benguela to Durban, 3700 kilometres, in sixteen months; Lieut. Weissmann from St. Paul de Loanda to Sadani, 4000 kilometres, in twenty-two months; Mr. Arnot from Durban to Benguela, 3500 kilometres, in thirty-nine months; Messrs. Capello and Ivens from Mossamedes to Quilimane, 4500 kilometres, in fourteen months. If these figures be accurate, it would appear that Mr. Stanley travelled more rapidly than any of the others, although he is closely pushed by MM. Capello and Ivens, for while his monthly average was about 349 kilometres, theirs was 321; but then his journey was about two and a half times longer than theirs in distance.

An official memorandum communicated to the German Reichstag lately gives some details about the Marshall Archipelago, of which Germany has just assumed the protectorate. It includes thirty lagoon islands or atolls, none of which rise more than ten feet above the sea. The vegetation is limited to the coca palm, the bandanas, and the bread-fruit tree. The native fauna are a small lizard, land- and water-crabs, and a few wild pigeons. There are absolutely no springs or running water, the inhabitants being dependent on rain-water caught in hollows and clefts in the rock, which rapidly becomes brackish on account of the porous medium. The group naturally divides itself into two chains, the eastern or Ratack, and the western or Ralick. It is in this latter that the largest island of the whole group, Jaluit, is situated. It has an area of about thirty-five square miles, contains about 1000 inhabitants, and possesses a good harbour. On it are the factories of the European and American Companies trading to the group. American missionaries have also stations there, the work of which is carried on by Sandwich Islanders.

A Russian scientific expedition to proceed to China is being organised under the direction of Dr. Piassetsky. The expenses will be provided partly by the Imperial Exchequer, and partly by the Moscow Commercial Committee.

The French Minister of Public Instruction has informed the Geographical Society of Paris that he has added to the Committee on historical and scientific work a section on historical and descriptive geography.

In the last number of the *Mittheilungen* of the Vienna Geographical Society (Bd. xxviii. No. 12) Herr Becker describes the "Blue Grotto of Busi," one of the Dalmatian Islands, which has only recently been discovered, and which owes its name to a peculiar light effect. It greatly resembles the celebrated "Grotta azzura" at Capri, but seems to be inferior to the latter in several respects. Herr Wienkowski has a curious paper on the "Pomeranian Kassubs," a remnant of the Wendic peoples which once inhabited the districts between the Saale and Elbe on one side and the Vistula on the other. The sub-title of the paper is, "A Contribution to the Ethnography of Germany." The Kassubs, although, according to a popular song of their own, as numerous as the sand on the sea-shore, now are very few in number, and their special characteristics are disappearing with the spread of a common school education. The writer gives an historical sketch of the Kassubs, describes their occupations, dwellings, clothing, food, marriage and harvest customs, the speech, and concludes with a few words on their proverbs and tales. Prof. Palacky gives a brief account of attempts at acclimatisation of plants in the Congo region, and a letter from Dr. Lenz from the Congo is also published.

THE BENEFITS WHICH SOCIETY DERIVES FROM UNIVERSITIES[1]

To be concerned in the establishment and development of a university is one of the noblest and most important tasks ever imposed on a community or on a set of men. It is an undertaking which calls for the exercise of the utmost care, for combination, co-operation, liberality, inquiry, patience, reticence, exertion, and never-ceasing watchfulness. It involves perplexities, delays, risks. Mistakes cannot possibly be avoided; heavy responsibility is never absent. But history and experience light up the problem; hope and faith give animation to the builders when they are weary and depressed. Deeply moved by these considerations, I desire to bring before you, my colleagues in this work, without whose labours all would be a failure, you who are Trustees, and you who are teachers, before the citizens of Baltimore, and before this company of students pressing forward to take the places of authority in the work of education and administration—before you all, my friends, I wish to bring some aspects of university life, which, if not new, may perhaps be stated in terms which are fresh, with illustrations drawn from our own experience.

I ask you to reflect at this time on the Relation of Universities to the Progress of Civilisation, and I begin by assuming that we are agreed substantially on the meaning of both these terms. The word university, as applied to a learned corporation, is several hundred years old, and in all times and lands has embodied the idea of the highest known agency for the promotion of knowledge and the education of youth. Civilisation is a new word, hardly introduced a century ago, though the idea which it embodies is as old as organic society. Guizot, to whose eloquence we owe the popularity of this term, avoids its formal definition, declaring in general terms that civilisation is the grand emporium of a people, in which all its wealth, all the elements of its life, all the powers of its existence, are stored up. "Wherever," as he goes on to say, "the exterior condition of man becomes enlarged, quickened, or improved, wherever the intellectual nature of man distinguishes itself by its energy, brilliancy, and its grandeur; wherever these two signs concur, and they often do so, notwithstanding the gravest imperfections in the social system, there man proclaims and applauds civilisation." Assuming, then, that by university the highest school is understood, and by civilisation the highest welfare of mankind, let us inquire into the influence which the advancement of knowledge by means of superior educational establishments has exerted or may exert upon the progress of society.

[1] An Address by D. C. Gilman, President of the Johns Hopkins University.

A little reflection will remind us of five great agencies by which modern Christian civilisation is helped forward: first, The Family, unit of our social organisation, recognised by Aristotle as the basis of society, and styled by modern philosophers "the focus of patriotism" (Lieber), and the very "starting-point of social morality" (Maurice); next, Trade or Commerce, the exchange of one man's products for another's, the traffic between communities and nations; third, Law and Custom, written and unwritten, the enforcement of duties and defence of rights, the equitable adjustment of conflicting claims; fourth, Religion, the acknowledgment of personal responsibility to an infinite and all-controlling Power. The last to be named is Knowledge, the recorded observations and experience of our race in ancient and in modern times, or, in other words, Scientia, science in its broadest significance.

These five influences working in dwelling houses, market places, state houses, churches, libraries, and schools, control our modern life; and that state of society is the best, in which domestic virtue, mercantile honour, and the freedom of exchange, obedience to law, pure and undefiled religion, and the general diffusion of knowledge, are the dominant characteristics. We are only concerned at present with the last of these five factors.

The means by which our race has acquired knowledge and preserved its experience are manifold. The inhabited world is a great laboratory, in which human society is busy experimenting. Observation, exploration, and reflection have been allied in interpreting the physical characteristics of the globe, ever since the primæval law, "Subdue the earth," was heard by primitive man; experiments in social organisation have also been made on a colossal scale, and in little microcosms; war has taught its pitiful lessons; superstition, irreligion, vice, and crime, as well as literature, art, law, religion, and philosophy, have all been teachers; customs, traditions, epics, creeds, codes, treaties, inscriptions, parchments, books, pyramids, temples, statues, museums, schools, pulpits, platforms, have all been employed to perpetuate and diffuse the knowledge which has been acquired; but ever since Europe emerged from the darkness of the Middle Ages, Universities have been among the most potent of all agencies for the advancement and promulgation of Learning. Their domain, the republic of letters, has been wider than the boundaries of any state; their citizens have not been restricted to any one vocabulary; their acquisitions have been hid in no crypt. They have gathered from all fields and distributed to all men. Themes the most recondite, facts the most hidden, relations the most complex, have been sought out and studied, that if possible the laws which govern the world might be discovered, and man made better.

In one of our halls there hangs a diagram which I never pass without pausing to think of its significance, listening as I would before the sphinx to discover if it has any message for me. It contains a list of European universities founded since the dawn of modern states—a period of more than seven centuries, a list of over two hundred names. Every state in Europe, every great city, has its high school. Popes, emperors, kings, and princes have been their founders; ecclesiastics, reformers, republics, municipalities, private citizens, munificent women, have contributed to their maintenance. Wherever European civilisation has gone, the idea of the university has been carried with it, to North and South America, to Australia, even to India, China, and Japan; it came with the Virginians to Williamsburg, with the New Englanders to Cambridge and New Haven; it was planted in California before there was an organised state on the Pacific slope.

The idea is often vague, sometimes perverted, commonly half-developed, at times inflated,—nevertheless it contains this principle of life, that in every civilised community there must be a high school, capping, crowning, binding, all other institutions for the advancement of learning.

Allow me to turn your attention to some historical illustrations. Notwithstanding the great renown of Charlemagne, greatest of monarchs between Cæsar and Napoleon, the fact that his empire was founded upon the principle of superior education is not so familiar; but a recent writer (Mr. Mullinger) has given us an instructive essay on the schools of Charles the Great, and a still more recent writer (Mr. R. L. Poole) has made a study of their influence. "If his reign marks the dividing line between ancient and modern history," says the latter, "it is not only by virtue of its political facts but also because he begins the education of the Northern races—fitting them in time to rule the world as the Romans had done before them."

A monk of St. Gall has preserved for us what purports to be an authentic account of the mode in which learning was introduced into the Frankish empire, and although the extract is long I am sure it will not weary you, as I read from the translation of Mr. Poole.

"When," says the monk, "the illustrious Charles had begun to reign alone in the western parts of the world, and the study of letters was everywhere well-nigh forgotten, in such sort that the worship of the true God declined, it chanced that two Scots from Ireland lighted with the British merchants on the coast of Gaul, men learned without compare, as well in secular as in sacred writings; who, since they showed nothing for sale, kept crying to the crowd that gathered to buy, 'If any man is desirous of wisdom, let him come to us and receive it; for we have it to sell.' This therefore they declared they had for sale, since they saw the people to traffic not in gifts but in salable things, so that they thus might either urge them to purchase wisdom like other goods, or, as the events following show, turn them by such declaration to wonder and astonishment. At length their cry being long continued was brought by certain that wondered at them or deemed them mad, to the ears of Charles, the king, always a lover and most desirous of wisdom: who, when he had called them with all haste into his presence, inquired if, as he understood by report, they had wisdom verily with them. 'Yea,' said they, 'we have it and are ready to impart to any that rightly seek it in the name of the Lord.' When therefore he had inquired what they would have in return for it, they answered, 'Only proper places and noble souls, and such things as we cannot travel without, food and wherewith to clothe ourselves.' Hearing this he was filled with great joy."

Several instances in modern history may be cited, in each of which the close of a great civil commotion has been marked by the foundation of a university. One of them is quite familiar. A little more than three hundred years ago, Leyden, so lately freed from the horrors of a siege, "so lately the victim of famine and pestilence, had crowned itself with flowers." The university was to be inaugurated. In the grand procession rode a female figure, the Holy Gospel, attended by Four Evangelists; then came other allegorical figures, emblematic of Law, Medicine, and the Liberal Arts, and then the magistrates and dignitaries. Down the Rhine floated the semblance of Apollo and the Muses, and each Professor, as he advanced, "was kissed by Apollo and all the nine Muses in turn," whose salutation found further expression in "an elegant Latin poem." I have taken these statements, as you doubtless surmise, from the pages of Motley, to show you the enthusiasm of the Low Countries in respect to their university; but a truer impression of the work then inaugurated would be given by recounting the roll of the great men who have taught in that university and of the great scholars whom they have trained. Grotius, Descartes, Scaliger, Boerhaave, Wyttenbach, Arminius, and Gomar, were among the early scholars who resided in Leyden, and the list might be extended until it reached our own contemporaries and our own countrymen.

A few years earlier, when the Reformation in England was nearly completed, Henry the Eighth reorganised the University of Cambridge, and laid the foundations of that splendid college, which might be called a university in itself, if ever a college could claim the more comprehensive name, Trinity College, which before the century had passed, trained for the world that great triumvirate whose statues glorify the approach to the chapel, Isaac Barrow, Lord Bacon, and Sir Isaac Newton, *qui genus humanum ingenio superavit*.

The foundation of the University of Berlin is a noteworthy modern instance of the erection of a great high school, in a time of national sorrow. The story has often been given, and was recently made the opening passage in an inaugural address by Helmholtz. Prussia had been overrun by France, the resources of the state were almost exhausted, but Frederick William the Third, led on by William von Humboldt, Stein, and other great intellects, determined to infuse new spirit into a despondent people, by conferring on them the greatest benefit which it was in his power to bestow, a university, founded on such a liberal plan, that it rose at once to the very front rank.

So within our recollection, that monarch's greater son, the Emperor William, when Strasburg had been reclaimed by Germany, determined that it should be the seat of a university, and already that new foundation stands among the strongest and best of German high schools.

These examples of universities founded each of them at the close of a sharp social crisis, often occurs to my mind when I remember that our foundation was projected at the close of a civil war, and was established in the firm belief that it would bind together in the love of Literature and Science all classes and all creeds. A physician who has lately died in communion with the Roman Catholic Church, has often said to me, "I tell everybody that there is one thing on which we can all agree, and that is the university," and another, of the same religious creed, has just written me, "I sincerely hope to see your prediction as to all Christian forces come true. Life is too short, and there is too much good to be done, to have any force or energy wasted in barren controversy."

I have made these historical allusions, most of which I am well aware are familiar, in order to raise the questions: Why is it that universities are so highly esteemed? What are the advantages which follow their foundation? Remembering that a university is the best organisation for the liberal education of individuals, and the best organisation for the advancement of science, apply the double test,—what is done for personal instruction, and what is done for the promotion of knowledge, and you will be able to judge any institution which assumes this name.

Ask, first, is it a place of sound education? Are the youth who are trained within its walls honest lovers of the truth,—are they learned, are they ready, are they trustworthy? When they leave the academic classes, do they soon find a demand for their services? Do they rise in professional life? Are they sought for as teachers? Do they show aptitude for mercantile, administrative, or editorial life? Do they acquit themselves with credit in the public service? Do the books they write find publishers? Do they win repute among those who have added to the sum of human knowledge? Have they the power of enjoying literature, music, art? Can they apply the lessons of history to the problems of our day? Are they always eager to enlarge their knowledge? Do they become conservative members of society, seeking for progress by steady improvements rather than by the powers of destruction and death? Are they useful, courteous, co-operative citizens, in all the relations of life? Do the charities, the churches, the schools, the public affairs of the community, receive their constant consideration? Are there frequent manifestations among them of unusual ability in science, in literature, in oratory, in administration? As the roll of the alumni increases and the graduates are counted by hundreds and not by scores, does it appear that a large proportion are men of honourable, faithful, learned, and public-spirited character? These are the questions by which, as the years go on, a university is to be tested, or to sum all questions in one, is it proved to be a place for the development of manliness?

I beg leave to dwell a little longer upon this text, because I think there is danger of its importance being overlooked. The material resources of a university, the aggregate numbers who attend its courses, its numerous buildings, its great collections, appeal to everybody,—only those who look at results are competent to give a conclusive opinion, and their opinion cannot be formed in one decade. A generation is the briefest period for a fair review. When the year of our Lord 1900 comes, this foundation will be a quarter of a century old. To that remote tribunal we appeal for judgment on our work of to-day. But we may anticipate this final verdict, and ascertain by our own inspection and inquiry what is done in any institution for the education of youth, what opportunities are afforded, how those advantages are regarded by the most intelligent young men, and what kind of scholarship is developed at the termination of the academic course.

Here let me protest against the common method of estimating intellectual work by numerical standards alone. I have heard it said that some men are possessed by a statistical devil. They can only think in figures: they will ask, in respect to a new acquaintance, how much is he worth; of a library, how many volumes; of an orchestra, how many pieces; of a college, how many students. I have known the expenses of an institution made a dividend, and the number of scholars the divisor, the quotient representing the cost of each pupil. All this is wrong, absolutely and wholly wrong. If such a standard were allowable, the largest number of scholars taught by the cheapest teacher would be the greatest success. It is not the number but the quality of students which determines the character of a high school. It is important to count; it is better to weigh.

Having spoken of what the university does for individuals, I add that it has a second function. It benefits associated as well as individual man. It renders services to the community which no demon of statistics can ever estimate, no mathematical process ever develop. These functions may be stated as the acquisition, conservation, refinement, and distribution of knowledge.

These carefully chosen words I proceed to explain.

1. It is the business of a university to advance knowledge; every professor must be a student. No history is so remote that it may be neglected; no law of mathematics is so hidden that it may not be sought out; no problem in respect to physics is so difficult that it must be shunned. No love of ease, no dread of labour, no fear of consequences, no desire for wealth, will divert a band of well chosen professors from uniting their forces in the prosecution of study. Rather let me say that there are heroes and martyrs, prophets and apostles of learning as there are of religion. To the claims of duty, to the responsibilities of station, to the voices of enlightened conscience, such men respond, and they throw their hearts into their work with as much devotion, and as little selfishness, as it is possible for human nature to exhibit. By their labours knowledge has been accumulated, intellectual capital has been acquired. In these processes of investigation the leading universities of the world have always been engaged.

This is what laboratories, museums, and libraries signify. Nothing is foreign to their purpose, and those who work in them are animated by the firm belief that the advancement of knowledge in any direction contributes to the welfare of man. Nor is research restricted to material things; the scholars of a university are equally interested in all that pertains to the nature of man, the growth of society, the study of language, and the establishment of the principles of intellectual and moral conduct.

2. Universities are conservative. They encourage the study of the history, the philosophy, the poetry, the drama, the politics, the religion, in fine, the experience of antecedent ages. Successors of the ancient monasteries, they keep alive in our day the knowledge of ancient languages and art, enrich the literature of our mother tongue, hold up to us the highest standards of excellence in writing, and enable us to share in the thoughts of the noblest of our race. Let me especially remind you that to the universities men turn instinctively for light on the interpretation of the Scriptures. When new manuscripts are discovered, or new versions are proposed, or new monuments are unearthed, it is to the universities, where the knowledge of ancient and remote tongues has been cherished, that the religious world looks for enlightenment and guidance. Their dominant influence is highly spiritualising; I would even go farther and say that it is truly religious. I am not unmindful that within the academic circles men are found whose spiritual insight is but dim—so it is in all other circles—but I assert, without fear of contradiction, that the influence of study is, on the whole, favourable to the growth of spiritual life, to the development of uprightness, unselfishness, and faith, or, in other words, it is opposed to epicureanism and materialism. In belief, there are tides as there are in the ocean, ebb and flow, ebb and flow; but the great ocean is there, with its deep mysteries, unchanging amid all superficial changes. Faith, with all its fluctuations, is as permanently operative in human thought as Knowledge.

3. Universities are refining. They are constantly, by laborious processes, by intricate systems of co-operation, and by ingenious methods, engaged in eliminating human errors and in submitting all inherited possessions to those processes which remove the dross and perpetuate the gold. No truth which has once been discovered is allowed to perish,—but the incrustations which cover it are removed. It is the universities which edit, interpret, translate, and reiterate the acquisitions of former generations both of literature and science. Their revelation of error is sometimes welcomed, but it is generally opposed; nevertheless the process goes on, indifferent alike to plaudits or reproaches. If their lessons are hard to the beginners, they lead the persevering to high enjoyment.

4. Universities distribute knowledge. The scholar does but half his duty who simply acquires knowledge. He must share his possessions with others. This is done in the first place by the instruction of pupils. Experience has certainly demonstrated that, with rare exceptions, those men are most learned who produce most. The process of acquiring seems to be promoted by that of imparting. The investigator who is surrounded by a bright circle of friendly inquisitors and critics finds his best powers developed by this influence. Next to its visible circle of pupils, the university should impart its acquisitions to the world of scholars. Learned publications are therefore to be encouraged. But beyond these formal and well recognised means of communicating knowledge, universities have innumerable less obvious, but not less useful, opportunities of conveying their benefits to the outside world.

These general principles I propose to illustrate by asking you to go with me around the circle of the sciences, that we may observe the part which universities have taken, or should take, in respect to the various departments of knowledge.

Let me begin by saying that a university should discover and teach all that can be known of the Human Body. If you ask me why this is so important, I reply, in order that every one may be able to lead a healthier, stronger, and more rational life than is now possible for the want of more knowledge. Hospitals are essential to alleviate sufferings which have been encountered; physical training is of great value; but still more important to humanity is the laboratory in which are studied the laws of life. A celebrated physiologist declares that "a hundred years of life is what Providence intended for man," and others tell us that most of our minor ailments may easily be avoided, and the number of efficient days may be largely increased. Science has proved that many diseases which used to scourge the civilised world may be prevented, and it has recently brought us within sight of new discoveries which will still further interrupt the progress of pestilence. The discoveries of anæsthetics have marvellously alleviated the sufferings of humanity. The causes and remedies of cerebral excitement and degeneration have never been understood as now, and the possibilities have never been so great for the restoration to their normal activity of the powers which have been alienated. In view of these great results and of these anticipations, it is clearly the duty of a university to study all the forms and functions of life which are manifested in organisms lower than man, all the laws which govern animal and vegetable growth, all that can possibly throw light on human physiology.

Those who are devoted to research of this kind, revealing with their microscopes the structure and the life-histories of the minutest organisms, are constantly, and in most unexpected ways, coming upon new illustrations of the plan of creation, which have an important bearing upon the welfare of man. They are the interpreters of nature and the benefactors of humanity; and I do not hesitate to add that if there is any branch of learning which at the present time deserves the most generous support, it is surely Biology, because of its obvious relations to the health and happiness of every human being. I cannot but think that those who oppose its study will be ranked in future years among the obscurantists of the nineteenth century.

(*To be continued.*)

PRJEVALSKY'S EXPLORATIONS IN CENTRAL ASIA

THE last number of the *Izvestia* of the Russian Geographical Society (xxi. 3) contains a letter from M. Prjevalsky, dated Lob-nor, January 29, 1885. After having spent a month at Tsaidam, the expedition undertook, in August, its journey towards the west. A special disease, called *khasa* by the Mongols, and consisting in a strong fluxion of all four feet, attacked fifty-three camels of the caravan, as well as all the cattle of the Mongols, and compelled the expedition to stop for a fortnight. Only seven camels succumbed to the disease, and on September 18 the expedition resumed its further advance, following the foot-hills of the Kuen-lun—that is, of the border-range of the plateau of Thibet. Southern Tsaidam is an immense flat land, formerly the bottom of a lake, covered with brushwood at the foot of the mountains, and with salt clay elsewhere. A narrow salt lake, Dobasun-nor, extending west to east, receives the rivers Bayan-gol, Naidmin-gol, and Umu-muren. Pheasants are numerous in the brush and the small marshes covered with rush. Other birds, even migratory, are very few, as also the mammals, which must avoid a ground impregnated with salt. Only bears coming from Thibet are numerous when the fruits of the *khormyk*-brush are ripe. During Chingiz Khan's time the legend says, the region was inhabited by agriculturists, "Mongasy," who left their traces in irrigation canals; but now all Tsaidam is peopled only with Mongols, thinning in the south, living on cattle-breeding. The Umu-muren is the western boundary of the plains impregnated with salt of the southern Tsaidam. Further north and north-west, as far as the Altyn-tagh Mountains, extends an immense dry desert, the soil of which consists of clay, sand, and gravel. Several of its parts man never visits, and only savage camels wander on its barren surface. M. Prjevalsky met with only two places having plenty of fresh water and grazing grounds: at Hansy and at Has, where a lake of the same name has a circumference of nearly thirty miles. Two Cossacks were sent from Has to discover a route towards Lob-nor, and after a fortnight's searching they succeeded in finding a place reached by M. Prjevalsky in 1877.

Leaving at Has some provisions under the guard of seven Cossacks, the remainder of the party went west to explore the valley nearly 150 miles long between the Altyn-tagh, in the north, and the Kuen-lun, in the south; the valley slowly rises from 9000 feet at Has to 14,000 feet at the junction of both chains of mountains. An easy passage across the Altyn-tagh leads them to Cherchen, and must have been utilised formerly on the route from Khotan to China, while another route led, *viâ* Lob-nor, to the Sa-cheu oasis.

The excursions of the party around Has took fifty-four days, during which a region absolutely unknown before was explored. It has a very poor flora and fauna; of mammals only a hundred antelopes were shot, and a new species of *Ovis* has been discovered. M. Prjevalsky gave it the name of *Ovis dalai-lamæ*.

Most valuable geographical discoveries were made with regard to the central part of the Kuen-lun. In the longitude of Hansy this immense border-range of the Thibetan plateau is snow-clad, and reaches, under the name of Jin-ri, the height of 20,000 feet. To the east of this mountain-mass runs a chain named Marco Polo, which is accompanied on the north by a series of ridges parallel to it, and described under the names of Garynga, Dzukha, Toroi, and several others, until the Burkhan-buddha range. To the north-west of the Jin-ri, another snow-clad range, named "Columbus" by M. Prjevalsky, followed by a third range, also snow-clad and formerly unknown, continues further, to join the Altyn-tagh. A range, which has been seen only at a distance, and called "Problematic," runs due west of Jin-ri, and probably reaches also the Altyn-tagh; a high range, 12,500 to 13,000 feet above the sea-level, including an elongated salt lake, which does not freeze in winter, occupies the space between the "Problematic" ridge and those situated towards the north.

The climate of the region is very severe. In December the temperature was seen to fall during the night below 40° Cels. Day and night strong westerly winds were blowing, often taking the force of a gale which filled the atmosphere with sand and dust. Snow was very scarce; so also must be the rains in the summer, as far as one may judge by the barrenness of the region; this part of the Thibetan mountains must escape the influence of the south-westerly monsoons of India, which bring so much moistness to North-Eastern Thibet. Water, however, is not scarce; the snow-summits supply many small rivers which flow from the mountains. Remains of summer-stations are seen on these rivers and streamlets, people coming there in search of gold, which seems to be as usual in North-West as in North-Eastern Thibet.

Returning in January to the station of Has, M. Prjevalsky resumed his journey to Lob-nor, 170 miles distant, where he was well received by his former acquaintances. There he proposed to stay throughout February to study the migrations of birds.

As known from his telegrams dated June 20 and July 13 (received on August 31), the expedition reached Keria, but was prevented from penetrating thence into Thibet, and the indefatigable traveller proposed to march on Khotan, and thence to Aksu.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Class List of the Mathematical Tripos Part III., just issued, for which only wranglers can enter, contains in the first class the names of Messrs. Barnard (Emmanuel), 4th Wrangler; Berry (King's), Senior; R. Holmes (St. John's), 5th; Love (St. John's), 2nd; Richmond (King's), 3rd; and Roseveare (St. John's), bracketed 6th. Thus it includes the first five Wranglers, and one of the two bracketed sixth. The names are in alphabetical order.

The Sidgwick Prize has been awarded to Mr. T. Roberts, B.A., St. John's College.

The long list of lectures for this term, issued by the Special Board for Physics and Chemistry, includes, in addition to the ordinary courses of Prof. Liveing, Prof. Dewar, and Mr. Main, Mr. Pattison Muir's, on Principles of Chemistry; Dr. Kuhemann's, on Methods of Analysis and Principles of Organic Chemistry; and Mr. Heycock's, on Chemical Philosophy.

Demonstrations and practical courses suited to the various classes of students, will be given in the University, St. John's, Caius, and Sidney College Laboratories, and Prof. Liveing gives a course of Spectroscopic Chemistry; and Mr. Robinson, one on Chemistry as Applied to Agriculture.

The courses of Physics include Prof. Thomson, on Magnetism; and lectures on various branches by Messrs. Atkinson, Glazebrook, Shaw, and Hart; and practical courses at the Cavendish Laboratory. Elementary and Advanced Demonstrations in Mineralogy will be given.

Prof. Stuart is lecturing on Theory of Structures.

In Geology Prof. Hughes begins a course of lectures on a district to be visited at Easter on January 26, and also lectures on the Principles of Geology. Other work is divided among Messrs. Teall, T. Roberts, Marr, and Harker.

In Physiology the usual lectures are being given by Prof. Foster, Drs. Lea, Gaskell, and Hill, and Mr. Langley. Prof. Macalister lectures on the Organs of Digestion and Reproduction; Prof. Newton on the Geographical Distribution of Vertebrates. Mr. Hans Gadow's course is on the Morphology of the Sauropsida (recent and extinct); other courses are conducted by Messrs. Sedgwick, Harmer, and Weldon.

Dr. Vines's general elementary course of Botany is continued, supplemented by Mr. F. Darwin on the Biology of Plants (advanced); Mr. Gardiner on the Anatomy of Plants (advanced); Mr. Potter's demonstrations on Advanced Systematic Botany.

Advanced work in Mathematics is represented by Prof. Stokes on Physical Optics, Prof. Adams on Lunar Theory, and Prof. Thomson on Electro-magnetism. Mr. Glazebrook is lecturing on the Theory of Light, Mr. Hobson on Higher Dynamics, Mr. Macaulay on Thermodynamics, and Mr. Forsyth on Higher Algebra. Dr. Besant lectures on Analysis, Mr. H. M. Taylor on Higher Plane Curves, Mr. Stearn on Electrostatics, Mr. Larmor on Theory of Conduction and Analytical Optics.

THE number of students inscribed in the several Universities of the Italian kingdom amounts to 15,151; excepting 200 who follow the free Universities, all of them follow the Government teachers, viz. law students, 5133; medical, 6132; science, 1627; literature and philosophy, 441. The largest number of students in proportion to the population is recorded in Central Italy, the largest number of law students in the Neapolitan States, the largest number of science students in Northern Italy, the largest proportional number of philosophical and literary students in Central Italy.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science, No. ci., November 1885, contains:—On the relations of the yolk to the gastrula in Teleosteans and in other Vertebrate types, by J. T. Cunningham (plates 1–4).—On the structure and function of the sphæridia of the Echinoidea, by Howard Ayers (plate 5). Suggests that these organs have for their function the perception of chemical changes in the surrounding water (*i.e.* taste and smell), and the reporting of the same to the nervous centres of the animal, from whence the intelligence is sent out to the spines and pedicellariæ, which latter are at once alert to secure the food-substance.—The nerve-terminations in the cutaneous epithelium of the tadpole, by A. B. Macallum (plate 6). The results are summarised as follows:—(1) Certain fibres of the nerve network, situated below the corium, and known as the fundamental plexus, give origin to fibres which enter the epithelium, and terminate in comparatively large bead-like bodies between the cells. (2) From a network of fine anastomising nerve-fibrils situated immediately below the epithelium, and forming meshes, each narrower than the surface covered by an epithelial cell, arise other excessively fine fibrils, which end either within or between the cells or after branching, in both fashions. (3) One, commonly two, often three or more, nerve-fibrils terminate in the interior of each epithelial cell near its nucleus. (4) The figures of Eberth are sheaths for intracellular nerve terminations.—On green oysters, by Prof. E. Ray Lankester (plate 7). The occurrence of a species of Navicula in the intestine of the green oysters of Marennes, is confirmed. The bluish pigment in the Navicula is described as "Marennin." The description and illustration of the secretion-cells of the epithelium of the branchiæ and labial tentacles of the oyster in which the Marennin absorbed in the intestine of green oysters is deposited follows, and it is proved that it is to this substance that the green parts owe their colour. The green oyster is very beautifully figured, of natural size, from a sketch by Miss A. Stone. The bluish pigment is, in the early spring, of a decidedly green hue.—The system of branchial sense-organs and their associated ganglia in Ichthyopsida: a contribution to the ancestral history of Vertebrates, by Dr. John Beard (plates 8–10).

American Journal of Science, December 1885.—On the effect on the earth's velocity produced by small bodies passing near the earth, by H. A. Newton. It is shown that the effect upon the earth's motion caused by the meteors that penetrate the earth's atmosphere, exceeds at least one-hundredfold that caused by the meteors that pass by without impact.—Sources of trend and crustal surplusage in mountain structures, by Alexander Winchell. The general meridional trend of the older mountain systems is discussed, and the cause of this orographic disposition is referred to the early period of incrustation. It is also argued that meridional trends would be further promoted by the secular subsidence of the earth's equatorial protuberance, as well as by lunar tidal action.—The genealogy and the age of the species in the Southern Old Tertiary, part iii., reply to criticisms, by Otto Meyer. In reply to Prof. Hilgard, the author maintains with further argument the original contention that only a competent and careful examination of the fossils could indicate the relations of the Old Tertiary strata of Mississippi. He also endeavours to show that Prof. Hilgard's views on the stratigraphical succession below Claiborne, Jackson, and Vicksburg are incorrect.—The condensing hygrometer and psychrometer, by Henry A. Hazen. Objections are raised against the condensing hygrometers now in use, such as those of Mr. Dines and Crova. An efficient psychrometer is described, with instructions for its use, and a table of relative humidity applicable to the sling psychrometer.—A new form of absorption cell, by Arthur E. Bostwick. The cell here described has been devised and used by the author for the purpose of obtaining the absorption-spectra of liquids, which have little selective absorption, and which would therefore have to be used ordinarily in large quantities.—Preliminary notice of fossils in the Hudson River slates of the southern part of Orange County, New York, and elsewhere, by Nelson H. Darton. Here the author deals with the fossils discovered in many new localities, which have thrown much light on the complicated stratigraphic structure of these districts.—Report of the American Committee-Delegates to the Berlin International Geological Congress, held September 28 to October 3, 1885, by Persifor Frazer, Secretary.—Bright lines in stellar spectra, by O. T. Sherman. Bright lines hitherto admitted to form part of but six stars, β Lyræ, γ Cassiopeiæ, and four small stars in Cygnus, are now detected by the 8-inch equatorial of Yale College Observatory in numerous other stars, a full description of which awaits the completed apparatus. The number of approximate coincidences renders it very probable that the lines observed are those of the solar atmosphere, and from these observations it would seem that there are many stars in the same condition as the sun, but with the corona more pronounced.—Note on the optical properties of rock-salt, by S. P. Langley. The most perfect rock-salt prisms procurable in Europe fail to show distinctly a single Frauenhofer line. But, after long searching, blocks have at last been obtained in America, from which prisms have been cut which show these lines with all the sharpness of flint glass. The prism here described, which has been made by Brashear of Pittsburgh, shows the nickel line between the D's.

SOCIETIES AND ACADEMIES

London

Royal Society, December 17, 1885.—"Second Report on the Evidence of Fossil Plants regarding the Age of the Tertiary Basalts of the North-East Atlantic." By J. Starkie Gardner. Communicated by Sir J. D. Hooker, K.C.S.I., F.R.S.

The position and physiography of this headland in the Isle of Mull has been fully described by the Duke of Argyll. It is the point of land separating Loch Laigh and Loch Scridain, and is about two miles in circumference and a mile across.

It is composed mainly of two sheets of basalt with remains of a third sheet, on some eminences and along the shore of Loch Laigh. These are almost horizontal, with a slight dip east, up Loch Scridain, and a considerable dip in the same direction up Loch Laigh. The upper sheet is not less than 40 to 50 feet thick, crystallised into rude massive columns, now much fissured and weathered, whilst the lowest presents a thickness of 60 feet, visible above low water, the upper two-thirds being amorphous, and the rest fashioned into slender and most perfect columns, bent in every direction, like those of the Clam-shell cave at Staffa. The beds are so exceedingly horizontal towards the seaward direction, that no one can doubt the columnar basalts of Staffa and the Treshnish Isles, Geometra and the mainland of Mull, being on the same horizon, if not parts of the same sheet. Between the two great lava-beds at Ardtun is intercalated a bed of sedimentary deposit, reaching a maximum of 60 feet thick, and consisting of pale very fine-grained clay and limestone at the base, then sand and gravel, black laminated shales, whinstone, gravel, and laminated sands. The gravels are made up of flint pebbles and subangular rolled fragments of older lava-beds in a matrix of broken-down volcanic material. They present all the ordinary lines of current bedding, beautifully weathered out, and the pebbles are drifted precisely as in ordinary river gravels.

There can be no question whatever, indeed, but that the gravels are the deposits of the waterway of a river of some magnitude, and the shales its overflows and backwaters. Its deposits traverse the whole seaward face of the headland, and their extension inland is marked by two beds of coal. An intrusive sheet of fine compact basalt rises on one side of the head, cutting a devious way through each bed in turn, and dipping beneath the sea at the other extremity. On the coast, near the centre of the head, occurs a small chine, apparently due to the weathering out of a vertical dyke, which has cut through the gravels and shales; it was here that I resolved to excavate them.

With the assistance of a barrel of powder and the removal of a mass of the intensely indurated shingle bed, to the extent of perhaps hundreds of tons, many square yards of the whinstone and the underlying black shales were exposed. The large specimens of *Platanites aceroides* and *Onoclea hebridica*, now exhibited, were the results. The ravine, however, proved an unfortunate selection, for the whinstone became poorer in fossils as we got farther in, and the underlying black shales, though crowded with leaves, were so squeezed and full of slickensides or faulted surfaces, and, consequently, so brittle, as to be practically valueless. From the condition of the shales and calcined appearance of the gravels—here of a steely-gray colour, intensely hard, with pure white and occasionally cherry-coloured flints, it is evident that the ravine must be the site of an old dyke, and if proof were wanting of a violent upthrust at this spot it is to be found in the upturned edges of the bottom bed on the west face. The succession of beds in the section we had been so laboriously working at in the ravine in no way prepared me for the discovery that within 100 yards there existed, many feet below the lowest sedimentary bed present in the ravine, a deposit of limestone, rivalling in fineness and texture the celebrated lithographic stone of Solenhofen, and containing exquisitely-preserved leaves, completely different in character to any previously seen in the basalts.

The new flora differs considerably from that of the shales above, and very large leaves of many kinds occur in the clay at the base. The leaves in the limestone are smaller and very sparsely scattered through it; there are, moreover, no cleavage planes, and hence much patience is required to obtain and develop them. I have obtained about twenty species of dicotyledon from it, the most prevalent being *Grewia crenata*, Hr., and *Corylus MacQuarrii*, Forbes, and *Acer arcticum*, Hr., all of which are also found in beds of the same age in Greenland. There are no ferns and only three conifers, a large variety of *Ginkgo adiantoides*, Unger., a new *Podocarpus*, the most northerly species found, and *Taxus Campbelli*. The fragments from the clays show about eight additional species, and altogether I should judge that both floras were very rich. The most characteristic plants of the shales are those described by the Duke of Argyll and Edward Forbes, *Platanites aceroides* and *Rhamnites multinervis*. *Taxites Campbelli* is not, as affirmed by Heer, identical with *Sequoia Langsdorfii*, but is a true *Taxus*. Other leaves are certainly referable to *Protophyllum*, and we have representatives of leaves determined as *Alnus*, *Cornus*, *Berchemia*, *Populus*, and *Corylus*—but among them there are none, so far as I can ascertain, that have ever been found in European beds of Miocene age. The flora seems to bear a *primâ facie* resemblance to Cretaceous floras of America rather than to any yet known from Europe. The resemblance of the Coniferæ to those indigenous to China at the present day is too remarkable to be overlooked.

It has become evident that the fluviatile rocks of the British basalts are of far greater extent and importance than had hitherto been imagined. Their base is exposed at Burg Head on the opposite side of Loch Scridain, resting upon Jurassic rocks and fragmentary masses of chalk, and is formed of two immense sheets of ash, the lowest of which is full of scoriæ. About 100 feet above these, resting upon columnar basalt, are sands and clays from 9 to 12 feet thick, in every respect similar to those of Ardtun Head. Overlying these is a bed of rudely columnar basalt, and there cannot be much doubt about the fluviatile series on both sides of the loch being upon the same horizon. The beds are, in fact, seen to be horizontal to the west as far as the eye can reach. The horizon of the Ardtun gravels would, therefore, seem to be about 150 feet from the base of the series. Taking into account the superior thickness of the basalts in Mull, and above all the presence of ash-beds at their base, it seems probable that they were nearer the vents than Antrim, and that their lowest beds are at least not newer, so that the Mull leaf-beds at 150 feet from the base should be much older than the Glenarm and Ballypalady leaf-beds at 600 feet from the base.

The horizontal extent of the fluviatile beds of Mull is more difficult to estimate. Gravels and fluviatile beds exist in many localities, and black shales, with identical leaves, have been found in Canna, and leaflets of *Taxus* or a similar foliaged conifer at Uig.

A very interesting relic of the Eocene vegetation occurs at Burg, for a large tree, with a trunk 5 feet in diameter, has been enveloped as it stood to a height of 40 feet, by one of the underlying lava-beds. Its solidity and girth enabled it to resist the fire, but it subsequently decayed, leaving a hollow cylinder filled in with debris, and lined apparently with the charred wood. There is also the limb of a larger tree in a fissure not far off. The wood proves to be coniferous, belonging possibly to the *Podocarpus*, whose leaves are so conspicuous in the beds above.

Mathematical Society, January 14.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. J. B. Colgrove, Loughborough Grammar School, was elected a Member, and Mr. S. O. Roberts was admitted into the Society.—Mrs. Bryant, D.Sc., read a paper on logarithms in general logic. An animated discussion followed between the author and Mr. Kempe, F.R.S., in which Prof. Sylvester, the President, and Mr. S. Roberts, F.R.S., also took part.—Mr. J. Hammond (Prof. Sylvester in the chair) read a paper on a class of integrable reciprocants (see report of Prof. Sylvester's Oxford lecture in NATURE, January 7, p. 222).—Capt. Macmahon made a short communication also bearing on reciprocants.

Chemical Society, December 17, 1885.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following circular letter was read by the Secretary:—

Elizabeth Thompson Science Fund.—This Fund, which has been established by Mrs. Elizabeth Thompson, of Stamford, Connecticut, "for the advancement and prosecution of scientific research in its broadest sense," now amounts to 25,000 dollars. As the income is already available, the trustees desire to receive applications for appropriations in aid of scientific work. This endowment is not for the benefit of any one department of science, but it is the intention of the trustees to give the preference to those investigations, *not already otherwise provided for*, which have for their object the advancement of human knowledge, or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance.

Applications for assistance from this fund should be accompanied by a full statement of the nature of the investigation, of the conditions under which it is to be prosecuted, and of the manner in which the appropriation asked for is to be expended. The applications should be forwarded to the Secretary of the Board of Trustees, Dr. C. S. Minot, 25, Mt. Vernon Street, Boston, Mass., U.S.A.

The first grant will probably be made early in January, 1886.

(Signed) H. P. BOWDITCH, *President.*
WM. MINOT, Jun., *Treasurer.*
FRANCIS A. WALKER.
EDW. C. PICKERING.
CHARLES SEDGWICK MINOT, *Secretary.*

The following papers were read:—The action of steam on carbonic oxide, by H. B. Dixon. The action of steam in determining the union of carbonic oxide and oxygen has been explained by the author as leading to an alternate reduction and oxidation whereby the hydrogen conveys the oxygen to the carbonic oxide:—(1) $CO + H_2O = CO_2 + H_2$; (2) $2H_2 + O_2 = 2H_2O$. This explanation has been rejected by Moritz Traube (*Ber.*, 1885, p. 1890) on the ground that carbonic oxide does not decompose steam at a high temperature. Traube represents the influence of steam as consisting in the formation from it of peroxide of hydrogen, which oxidises carbonic oxide, steam being re-formed. The author has already shown that steam is decomposed by carbonic oxide at a high temperature, for when carbonic oxide is exploded in presence of steam with insufficient oxygen to completely burn it, the carbon dioxide formed is more than double the oxygen, and hydrogen is found in the residue. Horstmann arrived at the same conclusion. When sparks are passed through a mixture of steam and carbonic oxide, carbon dioxide and hydrogen are formed until a certain fraction (which varies with the nature of the spark) of the carbonic oxide is turned into carbon dioxide. When sparks are passed through a mixture of carbon dioxide and hydrogen, carbonic oxide and steam are formed until a certain fraction of the carbon dioxide is turned into carbonic oxide. In neither case is the reaction complete. An equilibrium is reached when about 10 per cent. of carbon dioxide is present to 90 per cent. of carbonic oxide. By the prolonged passage of the sparks a considerable quantity of formic acid is produced. When a coil of platinum wire is heated to redness in steam and carbonic oxide, carbon dioxide and hydrogen are formed until from 10 to 15 per cent. of the carbonic oxide has been oxidised. Similarly, when a coil of platinum wire is heated in carbon dioxide and hydrogen, carbonic oxide and steam are formed until the corresponding limit is reached. No formic acid is produced. When a coil of wire is maintained at a red heat in a mixture of carbonic oxide and steam, and the carbon dioxide formed is removed by means of a dilute solution of potash, the carbonic oxide is in time completely oxidised to carbon dioxide with the liberation of the corresponding volume of hydrogen. Similarly, when a coil of platinum wire is maintained at a red heat in a mixture of carbon monoxide and hydrogen, and the steam formed is removed by means of phosphoric oxide, the carbon dioxide is in time completely reduced to carbonic oxide. Since these experiments were made Naumann has shown that when carbonic oxide and steam are heated in a tube to 950°, 10·5 per cent. of carbonic oxide is turned into carbon dioxide.—On multiple sulphates, by Miss E. Aston and S. U. Pickering.—On the use of ferrous sulphate in agriculture, by A. B. Griffiths, Ph.D.—On phenyltribromomethane, $C_6H_5.CBr_3$, by Walter H. Ince.

Institution of Civil Engineers, January 12.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was "On Gas Producers," by Mr. Frederick John Rowan.

EDINBURGH

Mathematical Society, January 8.—Dr. R. M. Ferguson, President, in the chair.—Mr. R. E. Allardice discussed a problem of symmetry in an algebraical function.—Mr. A. Y. Fraser gave an account of the methods for the quadrature of areas, especially by planimeters. He exhibited and described several of these instruments, including two of his own invention.

MANCHESTER

Literary and Philosophical Society, October 12, 1885.—Microscopical and Natural History Section.—Mr. Thomas Alcock, M.D., President of the Section, in the chair.—Prof. Boyd Dawkins, F.R.S., brought before the notice of the Section rock-specimens and microscopic slides illustrating the structure of the clay-slate of Snaefell in the Isle of Man.—Mr. Stirrup exhibited a small slab of the flexible sandstone of India.

SYDNEY

Royal Society of New South Wales, October 7, 1885.—Prof. Liversidge, F.R.S., President, in the chair.—Mr. Charles Moore, F.L.S., read a paper on the ringal of the North-West Himalayas, by Mr. Brandis (communicated by Baron von Müller, K.C.M.G.). Specimens of the bamboos now in this country were shown.—Prof. Liversidge exhibited a portion of a brick, the surface of which was green. The discolouration, he explained, was due to the presence of vanadium salts.

November 5.—Prof. Liversidge, F.R.S., President, in the chair.—The President referred to the loss the Society had sustained in the death of the senior Vice-President, the Hon. Prof. Smith, M.D., C.M.G., M.L.C.—Dr. Morris read some notes upon a very large number of experiments made with the view of discovering media having a higher refractive index than Canada balsam for the mounting of *Amphipleura pellucida*.—Mr. S. H. Cox, F.C.S., F.G.S., read some notes on the character of the Adelong Reefs.—The Rev. P. MacPherson described a collection of stone implements used by the Aborigines of Australia.—The Hon. J. M. Creed exhibited a pestle and mortar, used by the Aboriginals on the Murray River for grinding seeds.—Mr. H. C. Russell exhibited a new and simple form of tide-gauge.

PARIS

Academy of Sciences, January 11.—M. Jurien de la Gravière, President, in the chair.—Obituary notice of M. de Saint-Venant, Member of the Section for Mechanics, who died at Vendôme on January 6, by the President.—A new method for determining the elements of refraction, with a view to a more approximately correct knowledge of the true position of the heavenly bodies, by M. Lœwy. For this method it is claimed that it is extremely simple and direct, dispensing with the necessity of simultaneously ascertaining the value of any other quantity. It is also independent of any instrumental error, relying solely on differential measurements—that is, on operations by which alone a high degree of precision can be obtained.—Note on the constitution of the solar spots and on photography regarded as an instrument for discoveries in astronomy, by M. J. Janssen. These remarks are made in connection with a photographic image, presented by the author to the Academy, of the large spot visible on the solar disk on June 22, 1885, which was one of the largest hitherto observed. The image fixed on the photographic plate was formed with the violet rays of the region G, which affect the retina very feebly; hence, without the aid of photography, could scarcely ever be detected, even with the most powerful telescopes.—Note on the exceptional magnetic disturbance recorded by the magnetic registrar at the Observatory of the Parc Saint-Maur on January 9, by M. Mascart.—On the various states of the sulphur of antimony, which exists normally in two distinct states—that of a black crystallised sulphur, such as occurs in nature, and the orange hydrated sulphur obtained by precipitation, by M. Berthelot.—On the reciprocal actions and the equilibria established between the hydrochloric and hydrosulphuric acids and the salts of antimony, by M. Berthelot. It is shown: (1) That the inverse actions are produced in cases where the sign of the heat liberated by the reaction of two bodies, such as the sulphur of antimony and hydrochloric acid, is changed by the combination of one of them with a third body, such as water-forming hydrates, or even with one of the products of the reaction; (2) that the chemical action is not reversed abruptly, but according to a certain gradation of intermediate compounds, such as the hydrates, hydrosulphates, hydrochlorides, &c.; (3) that these secondary compounds exist for the most part only in a state of partial dissociation; (4) that they determine and regulate the chemical equilibria between the antagonistic bodies, according to the conditions of their own existence and dissociation; at this point intervene the physico-chemical laws of dissociation, which are at present being so actively investigated by chemists.—On alternating semi-anæsthesia regarded as a symptom of certain lesions of the rachidian bulb, by M. Vulpian.—Note on some meteorites which fell in the Hissar district, Punjab, on February 19, 1884, and at Chandpur, near Mainpuri, North-West Provinces, on April 6, 1885, by M. Daubrée. Both specimens, supplied to the author by Mr. Medlicott, of the Indian Geological Survey, appear to belong to the type of sporadic siderites, with respective densities 3·40 and 3·25.—Application of the transport of power by electricity in the cannon foundry of Bourges, by M. Favé. Since 1879 two movable cranes of 20 tons have been worked by electricity in this establishment without any accident.—Note on an arrangement of lenses with a great diameter and short focus presenting a very slight aberration, due to the late Col. Mangin, communicated by the Minister of War. The system consists of three lenses with a diameter of 0·60 metres, one bi-convex, the two others concavo-convex, having a resulting focal distance of about 1 metre. The curves are so calculated that there is nowhere a deviation of light of more than 2° 30′; and as the three lenses have no great thickness, the loss of light passing through them is scarcely one-twelfth, a loss more than compensated by the gain from the reduction of aberration.—Observations on Brooks's new comet made at the Paris Observatory (equatorial of the west tower), by M. G. Bigourdan.—Observations of the same comet made at the Observatory of Nice (Gautier's equatorial), by M. Charlois.—Summary of the solar observations made during the second half of the year 1885, by M. P. Tacchini. A progressive and rapid diminution of the solar spots was observed during the whole year, and especially during the last quarter. The faculæ were also less numerous, but the protuberances rather more frequent than in the previous six months.—On the propagation of sound in a cylindrical tube, in supplement to the labours of Regnault on this subject, by MM. Violle and Vautier. The main result of the experiments carried on in an underground conduit at Grenoble was that the velocity of propagation seemed to decrease with the intensity of the sound.—On the variations of the spectra of absorption and of the spectra of emission by the phosphorescence of the same body, by M. Henri Becquerel.—Note on the hydrates of hypophosphoric acid, by M. A. Joly. From the author's experiments this substance would appear to be as sharply determined by its crystallised hydrates as the phosphoric and phosphorous acids, and in the solid state it is fully as stable.—On the solubility of the sulphate of copper in presence of the sulphate of ammonia, by M. R. Engel.—On some combinations of acetimide with the metallic chlorides, by M. G. André.—Oh the preparation, properties, and reactions of iodaldehyde—

$$5C_2H_4O) + 4I + IO_3H = 5(C_2H_3IO) + 3H_2O,$$

by M. P. Chautard.—On the amylaceous granules of the cystosome of the gregarines, by M. E. Maupas.—On chlorophyll action (absorption of carbonic acid and emission of oxygen) in ultra-violet darkness, by MM. G. Bonnier and L. Mangin.—Verification of the existence of glacial formations in Equatorial Africa (Gold Coast between Cape Palmas and the Bight of Benin), by M. Chaper.—On the physiological action of the salts of lithium, rubidium, and potassium, by Mr. James Blake. It is shown that the relative toxic properties of the salts of lithium and rubidium increase with the atomic weight.—Researches on the coagulation of albumen, by M. Eug. Varenne.—Experiments showing that under certain conditions the charbon virus becomes attenuated in the ground, by M. V. Feltz.—On the transmission of glanders from mother to fœtus, by MM. Cadéac and Malet.—On the cultivation of wheat in the districts of Wardrecques (Pas-de-Calais) and Blaringhem (Nord), by MM. Porion and Dehérain.

BERLIN

Physical Society, Nov. 6, 1885.—Starting from the classical experiments of Bunsen and Roscoe respecting the action of light on a mixture of chlorine and hydrogen, Dr. Pringsheim had by recent experiments endeavoured to obtain a closer insight into the mode of the action of light. Light, as was known, was absorbed to a definite amount by chlorine, while hydrogen had a coefficient of absorption almost equal to zero. When now light passed through a mixture of chlorine and hydrogen, a part of the light was, in the first place, absorbed by the chlorine, just as though this gas were the only element through which it passed, and in all probability this absorbed amount was transformed into heat. In addition to this effect, on the other hand, the chemical affinity of the gases got excited, and in order to this operation light was likewise absorbed. Whether in this process we had a direct action of light-rays transformed into heat or only a kind of releasing influence on the part of the rays was a point that had yet to be determined. The difficulty of this determination was enhanced by the fact of the induction which Bunsen and Roscoe had already ascertained, in accordance with which the chemical combination of the chlorine with the hydrogen did not take place at once, but only a longer or shorter time after the beginning of the irradiation. By taking the gas-layer of great thickness Dr. Pringsheim was enabled to augment the time of the induction to twenty minutes, and the combination of the two gases was effected only in the twenty-first minute of the irradiation. For his experiments Dr. Pringsheim made use of a gas-developing apparatus in which concentrated hydrochloric acid underwent electrolysis by means of iridium electrodes, and from which the gases passed through a tube into a globular irradiation space whence a capillary, divided into millimetres, led to a vessel filled with water, from which, again, a thread of water penetrated into the capillary, and so served as index of the gas-pressure obtaining in the apparatus. Any heating influence expanded the gases and pushed the index outwards, while as often as hydrochloric acid was formed—the acid being at once absorbed by the water that was present in the insolation-globe—it caused an advance of the index, and the measure of this advance served as a criterion of the amount of acid formed. Experiments were next instituted in regard to the nature of the induction, and investigation was made as to whether it were identical with the chemical action of the light or were somewhat different from it. Sources of light of different intensity and different colour were examined in respect of their chemical and their inductive action, and it always turned out that the rays of most intense chemical action produced likewise the greatest induction. In the measurements of the chemical action of light, which were then taken in hand, a petroleum lamp was used as a source of light, the warm rays of the petroleum lamp being eliminated by means of an intercalated layer of water. Dr. Pringsheim first observed a sudden movement of the index outwards, which was at once followed by a speedy retirement to the initial position, and from this point the index was then observed proceeding slowly inwards, in proportion as muriatic acid was formed and absorbed. Seeing the first movement of the index might be interpreted as an effect of heat, control experiments were instituted with momentary illumination, at first by dropping a dark screen with small slit before the flame, and then by means of electric sparks. Each time now that the light ray struck the chlorine hydrogen gas mixture, the index was seen pushing suddenly outwards, and then as suddenly reverting to its former position, whence it then slowly retired inwards. There could, therefore, be no question in this case of any heating, but there must, on the contrary, be some other cause in operation, to the determination of which other experiments should be devoted.—Dr. König spoke on colour-blindness, and, in particular, on the important light it would throw on the theory of colours if, in addition to cases of red and green blindness, the existence of violet blindness could be demonstrated. Hitherto violet-blind persons had been described only by Herren Donders and Holmgren. These gentlemen had examined abnormal eyes, which, in the spectrum between red and green, saw a circumscribed gray band, exactly at the spot where, in the case of the violet-blind, the two remaining curves of colour-sensitiveness intersected each other. Last year, for the first time, Dr. König had an opportunity of examining an intelligent boy of from thirteen to fourteen years of age, who likewise testified to a quite distinct gray band in the spectrum between green and red, while he saw all other colours accurately. The belief that here was a case of a violet-blind person was, however, materially shattered when the spectral violet was presented quite pure and isolated before the boy. He then said he saw a colour which he had never before seen in his life. The boy was, therefore, not incapable of perceiving violet rays. Later, Dr. König had occasion to examine an eye affected with central turbidity of the retina, an eye which—so far as the experiments that were capable of being executed only with great care, allowed the determination of the matter—was, in point of fact, violet-blind. On investigating the neutral point, it was found with very great precision at the wave-length, 560·14. According to theory, the intersecting point of the red and green curve lay at 563·5 wave-length, very fairly, therefore, in agreement with the value thus found. The measurements of intensity between the wave-lengths 560 and 470 yielded values which likewise coincided exactly with those given theoretically for bichromatically violet-blind eyes. The now considerably more exact method for examining the colour-blind and the significance of these ascertained facts in relation to the theory would be set forth by Dr. König on a future occasion.—In the discussion which the first communication called forth, Prof. Landolt made the proposal of using a solution of lithium chloride in order to obtain, by way of electrolysis, a perfectly pure chlorine hydrogen gas mixture. In the case of electrolysis of hydrochloric acid there was a danger, he represented, of oxygen being united with the gas mixture. Prof. von Helmholtz said that the influence of the rays of light on the chlorine and hydrogen molecules might be conceived by supposing that they acted in a manner similar to that of elastic balls executing oscillations in a high-standing flat vessel, whereby they were continually passing up and down. Did one ball receive on some occasion or other a stronger impulse than usual, then it leaped over the edge and fell to the ground; so that in respect of the totality of movements in the vessel, a part of the energy was lost. In the same way, when an atom of chlorine and hydrogen approached so close to each other that they united chemically, a part of the energy of the oscillations of light became lost. In reference to the second communication (that of Dr. König), Prof. von Helmholtz set forth the difficulties of investigations of the kind in question, and laid special stress on a psychological difficulty. It was known that only the central part of the retina was trichromatic. With the part of the retina attaching itself peripherically, only two colours were seen, while the extreme region of the retina was monochromatic. Nevertheless, we always saw a white surface as white, whatever part of the retina were struck by these rays. It was plain that we had learned by experience to perceive objects that appeared white in the central field as white likewise when at the periphery they stimulated only two or but one kind of fibres. In all investigations into colour-blindness this psychological point was one which ought to be taken into quite material account.

CONTENTS

THURSDAY, JANUARY 28, 1886

LOUIS AGASSIZ

Louis Agassiz: His Life and Correspondence. Edited by Elizabeth Cary Agassiz. Two Volumes, 8vo. (London: Macmillan and Co., 1885.)

SELDOM has the influence of early environment been more marked in a scientific career than in the life of Louis Agassiz. Born in 1807 at the little village of Moṭier, in the plains of Switzerland, he passed his childhood on the shores of the Lake of Morat, the waters of which were a perennial source of delight to him. He took more special interest in its living things; knew the haunts and habits of its fishes, and could lure them to him by various ingenious boyish spells, or track them to their hiding-places in the old walls that were lapped by the water. He began to collect birds, insects, shells, and other objects long before he had acquired any book-knowledge of natural history. Between the Lake of Morat and the larger expanse of the Lake of Neuchâtel lies a strip of fertile country rich in woodlands and flowers, and full of bird-life. On the further side of Lake Morat, towering above the scene of the great battle wherein the Swiss routed the army of Charles the Bold, rise the far snowy summits of the Bernese Oberland. Nursed amid these surroundings, and encouraged and guided by wise parental care, the child most truly was father to the man. His intense love of nature and of all living creatures developed into the enthusiasm of one of the foremost naturalists of the time. His childish devotion to the fishes of Lake Morat settled into the earnest and untiring spirit of research among living and extinct fishes which made him the leading ichthyologist of Europe. His passion for the mountains with their snow-fields and glaciers grew into that clear insight and power of philosophical generalisation which have placed the name of Louis Agassiz at the very head of the pioneers by whom the story of the wonderful Ice Age has been unravelled.

The ardent boy with his eager pursuit of natural history was designed for commerce. His father, a poor country clergyman, had no fortune at his disposal which could save his son from the necessity of choosing a profession. But the studies and discipline of school life by no means checked the boy's longing for some career that would enable him to follow his bent towards the prosecution of science. He begged for two years more of the College at Lausanne, and this was granted by his parents, who, though they seem to have been quite aware of his peculiar abilities, never allowed themselves to lose sight of the necessity that their son should at all events qualify himself for some honourable means of making his own livelihood. His future appears to have been considerably influenced by a medical uncle at Lausanne, who, recognising the lad's special bent, suggested that he should take to medicine. This advice being followed, young Agassiz went for two years to the Medical School at Zürich, and then, at the age of nineteen, betook himself to the life of a German student at Heidelberg. It was there that his scientific career received its first great impetus, and that it became certain that, though he might persevere with his medical studies and take his degree, he would ultimately distinguish himself and make his career, not as a physician, but as a naturalist. At Heidelberg he laid the foundations of some of the most precious and enduring friendships of his life, more particularly with Alexander Braun the botanist, whose sister he afterwards married, and with whom and Schimper he next year migrated to Munich, famous at the time for the varied attainments of its professors of science and philosophy. Entering there on a wider field of study, Agassiz and his comrades distinguished themselves among the students by their enthusiastic devotion to natural science. Meeting at each other's rooms, they formed a band known outside as "the Little Academy," discoursing on all manner of questions, starting new problems, proposing solutions for old ones, and creating so much interest in their proceedings, that even learned professors were sometimes to be seen among their listeners.

It was but natural that in the midst of such a life the drudgery of the medical profession should grow more and more irksome. Again and again warning comes from home that the practical aim of his University studies must not be lost sight of, and that he must surely qualify himself to practise as a doctor. His mother's strong common sense would from time to time brush away the golden haze through which the hopeful enthusiast looked at his prospects. In her letters too, she warned him against his "mania for rushing full gallop into the future," engaging in too many different undertakings, and wasting by diffusion an energy which would carry him successfully to his goal, if he would only concentrate it upon what was essential for the purpose. Long before he took his medical degree his power of original research in ichthyology was widely known, and Martius placed in his hands for description the Brazilian fishes left undescribed by Spix. This work was completed and published in 1829, when the young author was only twenty-two years of age. Next year he gratified his parents by formally taking the degree of M.D.

But the prospect of settling down as a country medical practitioner was more than ever distasteful to him, though there seemed no very clear outlook in any other direction. He himself, however, was full of hope. His Brazilian fishes had brought him no money indeed, but it had given him a reputation throughout Europe as one of the rising naturalists of the day. Already he was full of schemes for the production of a work on fossil fishes, and he had actually made considerable progress in the preparation of a monograph on fresh-water fishes. He felt sure that he could command his own terms from publishers, and that the sale of the works would enable him to live in the quiet way he desired to do. So he went home for a year, which he spent in increasing his collections of natural history—now large and valuable—and in prosecuting the works on which he had been occupied at Munich. But his ambition to take a leading place among the naturalists of Europe, and the necessity for increasing his knowledge by study in some of the best museums of the Continent, led him at last irresistibly to Paris, where he arrived towards the end of the year 1831. From Cuvier he received much kindness. The veteran naturalist had made some progress with a work on fossil fishes, but when he saw what Agassiz had done and proposed to continue, he generously presented him with all his own drawings and notes upon the subject. A. von Humboldt also took the warmest interest in the young Swiss, aiding him by help of the friendliest and most practical kind. But Agassiz was still without any regular means of self-support; the publishing schemes were not so successful financially as he had fondly anticipated, and at last, after some months of over-strain among the treasures of the Paris museums, he gladly accepted, in the autumn of the year 1832, the offer of a Professorship of Natural Science created for him at Neuchâtel by the exertions of his friends. For the first time he had now the opportunity of appealing to a wider circle of listeners than his own fellow-students. The enthusiasm of his nature soon made itself felt in the new vigour with which natural science was followed in the canton. A Society for the prosecution of the study of nature was founded, with Agassiz as one of its leading spirits. Hill and dale, river and lake were explored far and near, and the systematic lectures of the class-room were supplemented by even more valuable discourses in the field. From this period onward a large part of Agassiz's time and thought was given to the promulgation of a knowledge of nature, not only to professed students but among the general public. With his extraordinary energy he still found time for an amount of original research that would have been more than enough for most naturalists. Bold almost to recklessness, in his disregard of financial difficulties, he now (1833) launched the first number of his "Poissons Fossiles," and, in spite of incredible obstacles, continued the preparation and publication of the work for the next ten years. In the course of his researches for this great monograph he came several times to England, bringing with him the artists he had trained in drawing natural history specimens, and spending much time in the public museums as well as in the private collections where he found such a wealth of palæontological material.

The "Poissons Fossiles" will ever remain as a monument of extraordinary industry and of a remarkable insight into the relationships between recent and extinct types of life. The keynote of all Agassiz's work in natural history sounds out clear and distinct in the introduction to this great work. He proposed a new classification of fishes which, though it has been subsequently considerably modified, was of great geological value in showing the true history and importance of the great order of Ganoids, which he first recognised. With a keen eye for real or supposed analogies and relationships, he saw in the earlier fishes of the geological record a commingling of ichthyic with reptilian characters which suggested to him his "prophetic types," and, following out the same idea, he made the startling announcement that in the phases of the embryonic development of our living fishes there is a close analogy to the successive types of fishes which have appeared in the past history of the earth. It is curious to remember that a naturalist who saw so far ahead of his contemporaries remained a consistent opponent of all theories of evolution. He admitted in the fullest sense the evidence of "the most admirable progressive development to which our own species is linked," but to him the progress was one of plan in the mind of the Creator, and not the mere material change of one form into another.

One of the most characteristic features of Agassiz's mind was its restless activity and untiring energy. The labour entailed by his great work on fossil fishes would have been enough or more than enough for any ordinary man. But while it was in progress he found time for the prosecution of his researches among recent fresh-water fishes; for an investigation of Echinoderms recent and fossil, and for the study of fossil Mollusca, and the evidence for these added labours appeared in bulky quarto memoirs with numerous plates. Besides these works, however, he undertook the almost incredible drudgery of compiling a zoological "Nomenclator," containing the names of living and fossil genera of animals, and a "Bibliographia Zoologiæ et Geologiæ," giving a full list of published papers on these sciences. Dissatisfied with the delays and defects of the Munich engraving establishments, he founded a lithographic workshop at Neuchâtel, and astonished the world by the beauty of the chromolithographed fossil fishes which he there produced, the art of chromolithography being then in its infancy.

With this mental activity was combined a bodily vigour which carried him unwearied through long excursions. As a recreation he turned to the glaciers of the Alps. Before his student days at Heidelberg he had made himself acquainted with that mountain-world. But in the summer of 1836, under the guidance of Charpentier, he began the systematic study of the glaciers. Before the end of that excursion he had seized the meaning of the scattered erratic blocks and ice-worn bosses of rock that lie far above and beyond the present limits of the ice. He saw as by a kind of inspiration the evidence for the former vast extension of the Alpine glaciers, and though he continued in later years laboriously to fill in the details of the picture, his first rough draft remained unchanged in all its essential features. As soon as he began to make known his ideas in glacial geology, he was met with a storm of opposition. Even his kind friend Humboldt could not forbear words of gentle reproof and warning. But he remained unshaken in his faith, and eventually had the satisfaction of seeing one after another of his opponents candidly acknowledge themselves mistaken. From 1836 to 1846 he continued with unabated enthusiasm his glacial researches, scaling mountain-pass and glacier, and publishing first his "Études sur les Glaciers" (1840), and then his "Système Glacière" (1846), besides separate papers in scientific journals. Among these minor contributions, undoubtedly the most memorable is the short communication made to the Geological Society of London in 1840 on the evidence of glaciers in Britain. Agassiz came to this country in that year convinced beforehand that there must be abundant evidence of former glaciers among our uplands. With the genial Buckland he went into the Scottish Highlands, and found everywhere, as he had anticipated, the most convincing proofs of ancient glaciers. From that time onward the study of Pleistocene geology took a new departure among the geologists of this country, and the opposition to glacial agency soon died out.

The "Poissons Fossiles" was followed soon after by the publication of the monograph on the fishes of the Old Red Sandstone—another land-mark in the progress of palæontology. Since the appearance of these works a new generation has appeared; the number and size of public and private collections have greatly increased, and the acilities for transport and for comparison of specimen with specimen have been enormously augmented. Those who revise the work of the great pioneer in fossil ichthyology will no doubt find much to amend, and no one knew this better than he himself. But hey will not forget the difficulties under whic worked, and which he so pathetically describes. It was an enormous service to science to group and describe, as he did, all that was then known of the fishes of the past.

During the years in which Agassiz was engaged upon these and kindred researches he often turned his eyes wistfully to America as a land where many of the problems that so profoundly interested him could be even better studied than in Europe. There were many obstacles in the way of his crossing the Atlantic. In 1833 he had married the sister of his old college friend, Braun, and a young family was growing up round him. The emoluments of his Professorship at Neuchâtel were scanty enough even for his domestic needs, and he always had scientific work on hand that could not make progress without money. At last, however, he saw his way to visit America and pay the expenses of the journey by lecturing.

It was in the beginning of October 1846 that Agassiz arrived in Boston. Intending at first merely to make a lecturing tour, seeing what he could of the country and the people, but returning eventually to his home and its duties at Neuchâtel, he was gradually led to prolong his stay in the United States. His pleasant, genial ways, his captivating enthusiasm as a naturalist, and his activity of mind and body, gained him many friends; and at last, in the early part of 1848, he was offered and accepted the Chair of Natural History in a scientific school then organised in connection with Harvard University. Thenceforward he became an American citizen, and the record of his life is that of the growth of a remarkable personal influence which, holding up constantly before the public the claims of natural science for recognition, carried away all kinds of obstacles, personal, political, and financial, and planted firmly in the national mind a deep respect for scientific worth and the value of scientific training—an influence too which powerfully affected the young intellects that came in contact with it, kindling in them a spirit of brotherly co-operation and emulation in the study of nature. Without following the details of his busy and useful career, we may note the frequent excursions to distant regions for the purpose of gaining fresh materials for study. Thus we find the Professor at one time navigating the bays and creeks of Lake Superior; at another exploring the Florida reefs; then sailing up the Amazon and investigating its natural history; or dredging among the West Indies; studying glaciers in the Straits of Magellan, and voyaging up the western coast of America to San Francisco. Of these various expeditions narratives were published giving a pleasant picture of the life of the naturalists and of the chief scientific results obtained by them. Turning over the reports, we every now and then come upon some pregnant suggestion, some luminous generalisation, or some significant deduction, showing how the characteristic breadth of grasp and clearness of insight had undergone no diminution by transference to the New World. What, for instance, can be more suggestive than the sentence with which Agassiz begins one of his reports on these deep-sea dredgings? "From what I have seen of the deep-sea bottom, I am already led to infer that among the rocks forming the bulk of the stratified crust of our globe, from the oldest to the youngest formation, there are probably none which have been formed in very deep waters." In this conclusion and in his inference that the oceanic and continental areas have retained from the beginning the same general positions, he anticipates some of the most remarkable results of later research. Again, how prescient was his expectation that the deeper sea would show relics of older types of life that had vanished from the shallower waters!

One of the most important of Agassiz's labours in America was the founding of the Museum of Comparative Zoology at Cambridge—a museum which should not only present an orderly reflection of the structure and history of the whole animal creation, past and present, but which should contain such ample store of duplicates as to offer to students unlimited means of practical study, and should thus become one of the great centres for the radiation of knowledge throughout the community. To the realisation of his dream of founding such a museum he devoted the best energies of the last twenty years of his life, and lived to see it established and recognised as one of the great scientific institutions of the world. Full of labours to the last, happy in the hearty recognition of his scientific contemporaries, happier still in troops of friends in the Old World and in the New, and soothed by the tender affection of a loved home circle, Agassiz died on December 14, 1873.

The memoir which is the subject of this article has been written by his widow, whom he married in America after the death of his first wife. It is a most interesting narrative, bringing before us the man as he was, and, though making no pretence to appraise his scientific work, yet giving a graphic picture of the conditions under which the work was done. A simple boulder from the glacier of the Aar rests above his grave in the cemetery at Mount Auburn; a few sapling pine-trees sent from his old home in Switzerland throw their shadow over stone and grass. And no more fitting memorial could have been added to these tributes of affection than the story of his life so simply and gracefully told by Mrs. Agassiz.

ARCH. GEIKIE

OUR BOOK SHELF

Die äusseren mechanischen Werkzeuge der Thiere. Von Vitus Graber. (Leipzig: G. Freytag, 1886.)

THIS little work appears as the 44th and 45th of a series which, under the title "Das Wissen der Gegenwart," is published at Leipzig. The series embraces works on Astronomy, Geology, Physics, Biology, as well as treatises on History, Geography, Philosophy, and Art, all of which are issued at the extremely low price of one mark each. The present work consists of two parts, each of about 220 pages, with illustrations, and treats of the mechanics of the animal machine. The first part is concerned with the Vertebrates—where the construction is more complex—and in eight chapters we have the first principles of mechanics, so far as they relate to animals in general, discussed, and then the actions involved in locomotion, prehension, &c., are treated of in detail. The second part glances at the same facts, so far as they are found manifested in the lower animals, more especially in the Arthropods, Mollusca, and Worms. Many of the woodcut illustrations are from original drawings, and of these those representing the muscles engaged in prehension and mastication are very good.

Animal Life on the Farm. By Prof. G. T. Brown, Agricultural Department, Privy Council. (London: Bradbury and Agnew.)

THIS is the last of a series of eight convenient handbooks covering the whole field of agricultural study. Dr. Masters's "Plant Life on the Farm" is ably followed by the excellent little book from the pen of Prof. Brown; and what may at first appear in the light of omissions in a treatise upon animal life as seen upon farms is at once corrected by the previously-published account of the live stock of the farm. Thus, while the subject of crops of the farm and live stock of the farm were ably treated, there was still room for more purely scientific writers, such as Dr. Masters and Prof. Brown, to treat of life more as biologists than as practical farmers. Accordingly, what is true of life on the farm is in many respects true of life in the forest and life in the city; but this does not detract from the value of facts about life wherever it may be found. It was probably an agreeable task to the writer to put this little volume together. It is full of matter with which he is very familiar, and which he is able to present with that admirable clearness and precision which has always characterised both his oral and written teaching. Commencing with the two opposite conditions of life, and death, as abstractions, we are pleasantly led to the consideration of the beginnings of life in the egg, and by a natural progress to a popular, but at the same time accurate, description of tissues, organs, and functions, which carry the reader through about two-thirds of the book. The remaining third is devoted to the peculiarities of domesticated animals, and in fact becomes more thoroughly specialised upon the farm. The variability, the precocity, the delicacy, the plasticity of domesticated animals are each dealt with by a master hand, and illustrated by examples taken from the experience of breeders and our great agricultural societies.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Iridescent Clouds

IN a letter published in NATURE for January 7 (p. 220), I tried to describe the appearance of the iridescent clouds as seen here on the afternoon of December 28. The phenomenon was repeated on December 29 and 31. On December 30, and again on January 1, the sky was overcast, but since then, though I have looked for them at different times of the day, and especially about sunrise and sunset, I have seen no further trace of iridescent clouds.

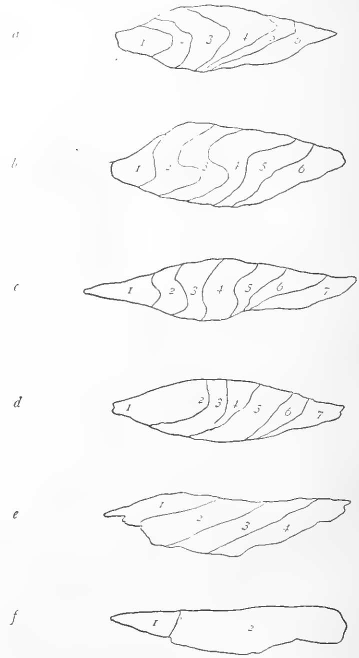
What struck me as most remarkable about them was, not the prevalent colour which they have been said to possess (see pp. 199, 219), for I cannot point out any as being peculiar to them, but the changes of colour undergone, often rapidly, by each individual cloud. As a record of these changes in the few instances I am able to give may perhaps help to throw some light on the nature and origin of these clouds, I trust I may be excused for occupying so much of your space.

December 29.—3.15 p.m., the sun a few degrees from setting, light cloud partly covering the sky, heavy snow-clouds near the horizon. At about 10° north of the sun and at an altitude of about 25°, there was a small cloud, 5° in length, consisting of four or five narrow bands nearly parallel to the horizon, all of a faint, but beautiful, violet colour. Soon after this, it was hidden by snow-clouds.

3.44.—This cloud was again visible, showing iridescent colours, no longer consisting of bands, but oval in form and slightly inclined to the north. Half a minute later, a branch of the same form and size, but rather more inclined to the north, appeared on the right, very faint, but increasing rapidly in brightness, until it equalled that of the original cloud. The new branch was at first violet, but in part tinged with rose-colour. The original cloud soon, however, began to fade, and by 3.47 had disappeared, the remainder being then green, except the upper edge slightly tinged with pink.

3.50.—The colours almost gone, but I believe the cloud was at this time covered by a thin haze. At 3.52 the cloud was very faint, and white.

Fig. I.



3.55.—The colours again appeared, in three bands, blue on the left (nearest the sun), green in the middle, and on the right pink. But, immediately, the colours began to change, the blue and pink to fade, the green band becoming wider and brighter, until, in a few seconds, the whole cloud was green. It grew brighter and brighter until, at 3.57, it shone out a pure beautiful green almost of rainbow-brightness. But, at this moment, the snow-clouds, which had been rising rapidly, passed over it, and heavy driving snow began to fall.

At 4.18 the snow-storm was over, and in nearly the same place as the cloud just described were two small clouds, each about 5° long, at altitudes of about 20° and 25° respectively. They were faint, and had a slight trace of indefinite colouring. By 4.26 they had both disappeared.

4.28.—The two clouds again visible, the lower green, and the upper rose-coloured. But the clouds began to fade at once, and a minute later both had disappeared finally, the sky being now, and continuing, quite clear.

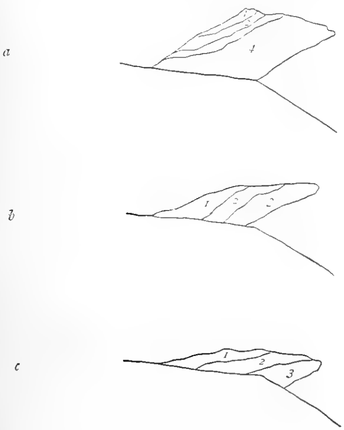
Besides these there were a few other small clouds, white, and of unusual character and brightness, but at no time did I detect in them any certain trace of colouring.

December 31.—At about 10 a.m., and for some time after, I noticed a small coloured cloud, above, but a little to the west of, the sun, and at an altitude of about 30°. The lower edge was blue, immediately above this a narrow band of green, the rest of the cloud being faint, almost colourless, but occasionally showing a slight yellowish tinge, and at the upper edge a touch of red.

At sunset there was the most wonderful display. At 4 p.m. in all parts of the sky were bands of light cirrus cloud, flushed with crimson by the setting sun. In the west, higher than the cirrus, and shining through them and in the intervals between, were splendid iridescent clouds, set off against a background of blue. I have never yet seen anything to equal the glory of this sky. It is impossible to describe it, the colours were so varied and their changes so rapid. I confined my attention, therefore, to the two largest and most beautiful clouds, and the following is a record of the colours and their variations, so far as I was able to observe them.

(1) One of these clouds is shown in Fig. 1. It was situated a few degrees south of west, about 20° above the horizon, and was about 15° in length and 5° in greatest breadth. During the whole time it seemed stationary, though changing slightly in

Fig. 2.



form. It was crossed by beautiful bands of colour, separated by fairly sharp lines. Sometimes, when the stripes of colour were narrow, I have included them in one band, to save time in drawing; the order being then given from left to right.

4.5 p.m.—Fig. 1, *a*. The right end of the cloud hazy. (1) Green, (2) yellow, orange, red; (3) blue, green, yellow, red; (4) red, with a tinge of purple; (5) bright purple; (6) red, green.

4.11.—Fig. 1, *b*. Both ends hazy. (1) Pink in the haze, blue; (2) yellow, green, orange; (3) green; (4) red; (5) blue; (6) red, ending in green in the haze.

4.18.—Fig. 1, *c*. The cloud rather longer and narrower than before. (1) Green; (2) green; (3) yellow, orange; (4) green; (5) red; (6) green; (7) red.

4.21.—The orange band 3 beginning to invade the green band 2.

4.22.—The red band 5 growing brighter.

4.25.—The red and orange bands, 3 and 5, widening, and becoming the predominant colours of the cloud.

4.27.—Fig. 1, *d*. (1) Light haze; (2) hazy; (3) red; (4) green; (5) bright red; (6) greenish; (7) orange red. The general hue of the cloud was at this time reddish orange, the red and orange bands being much brighter than the rest.

4.30.—Fig. 1, *e*. The outline hazy. (1) Haze; (2) red: (3) reddish orange; (4) red.

4.32.—Fig. 1, *f*. (1) Thin haze; (2) not quite so bright as before, but all of a deep rose-colour.

4.34.—The rose-coloured part had a slight tinge of purple, which, two minutes later, had become more marked, but rising clouds now stopped further observation.

(2) The other cloud was in a west-south-west direction, about 10° above the horizon, and partly hidden by a bank, which served, however, to show how slightly the cloud altered its position.

4.7 p.m.—Fig. 2, *a*. (1) Green; (2) orange red; (3) light green; (4) violet. All these colours very bright.

4.13.—The colours had changed, so that the general hue of the cloud was blue.

4.14.—Fig. 2, *b*. (1) Orange; (2) bright blue; (3) violet. The right edge hazy.

4.16.—The left side blue, the right violet, with a narrow pink band on the lower edge.

4.17.—The greater part of the cloud a very bright light blue, violet on the right, pink on the upper edge towards the left.

4.22.—Very faint and bluish.

4.25.—The cloud smaller, and bluish-green, but still faint.

4.26.—Green, and brighter.

4.29.—Fig. 2, *c*. The whole cloud much brighter, though not so bright as when first seen. (1) Reddish; (2) green; (3) reddish.

4.34.—The cloud the same shape as at 4.29, and the whole of it orange-coloured. After this moment it was hidden by heavy clouds.

Beside the two clouds above described, and several other smaller ones similar to them, there was visible in the west, at 4.26, a long narrow band of cloud (about 20° long and 3° or 4° broad), parallel to the horizon, and of a distinctly violet colour throughout. CHARLES DAVISON

Sunderland, January 12

Parallel Roads in Norway

IN Mr. Hansen's account of the terrace formation of Central Norway he discards the sea theory of their origin, as well as the detrital dam, the local glacier theory, and also that of Prof. Prestwich, of landslips. The cause he ascribes to rests in the passage of the inland ice seawards, allowing lakes to form in the watershed while ice remained in the valleys seaward. Does this idea not reverse the order of Nature? Would it not be far simpler, more reasonable, and more in accordance with the laws of Nature to conclude that ice would remain in the highest valleys of the country longest, and that the parallel roads or terraces are the ice margins or lateral moraines where the ice rested after the most intense glaciation ceased, while the surplus passed over the cols, and the passage seaward was more or less retarded by the configuration of the country? The Lochaber roads are mostly composed of the usual glacial stuff of the district, it is neither washed as lake margins or sea beaches. The only water-washed material seems to have run down from the hills above, before glaciation ceased, and vegetation covered the surface. The roads are neither strictly parallel or horizontal, and just what might be expected to be formed by ice lying for a long time in a valley when the growth did not greatly exceed the waste and the motion was slow. JAMES MELVIN

Edinburgh

Dew

HAVING read with interest the abstract in NATURE of January 14 (p. 256) of Mr. Aitken's observations on dew, I noted attentively during a walk this morning the behaviour of the hoar-frost as deposited on different objects. The morning was fine and frosty after a clear cold night. There was a copious deposit of hoar-frost upon the grass, upon the upper side of wooden rails, and upon the topmost twigs of the bushes in the tall hedges (6 to 8 feet high), but the lower twigs in the hedges had little or none. On stones in the road, as Mr. Aitken observes, there was little hoar-frost on the upper surface, only lines of ice crystals along the salient angles, but their under surfaces were thickly covered. With the loose heaps of broken stones by the road-sides the case was different: here the uppermost stones were thickly coated with frost on their upper surface, but had little on their lower surface; the stones underneath the uppermost layer, on the contrary, were coated with hoar-frost on their under, but not on their upper, surfaces. The hollow "cat's ice" on the road-side puddles, where previously unbroken, was copiously coated with ice crystals above, but only scantily underneath; but where the ice had been broken so that the cavity beneath it had communicated freely with the open air, the crop of ice crystals was equally copious on both sides. A large hollow iron roller, 24 inches in diameter, had a copious crop of ice crystals on the upper surface, but little on the sides. Underneath, however, it had a coating of ice which extended about an inch from the point at which it rested on the earth, and then ended abruptly.

These observations seem to show that for the formation of hoar-frost, and inferentially also of dew, upon solid bodies, two factors are necessary, viz. (1) a sufficient cooling of the bodies by radiation below the temperature of the surrounding air; and (2) a supply of watery vapour in the air; and that within certain limits an excess of one of these factors may compensate for a deficiency of the other. Thus upon the top twigs, on the uppermost stones in the heaps, and on the upper surface of the iron roller—all these bodies being freely exposed to radiation, and not directly connected with the warm earth—a copious deposit of hoar-frost took place; and this deposit, it is to be remarked, must have been condensed from the vapour diffused in the layers of air in contact with those bodies, and not from that issuing from the earth. Vapour from the ground could not pass through the impervious iron roller to reach the upper surface; it may indeed be supposed to have passed round the circumference, but the sides of the roller were, as I have said, comparatively free from hoar-frost. On the other hand, the under sides of the stones, and of the roller, though to a considerable extent protected from radiation, had on them a deposit of ice, seemingly condensed, as Mr. Aitken supposes, from the vapour exhaled from the comparatively warm ground beneath them.

The scantier deposit of hoar-frost upon the under surface of the "cat's ice" when unbroken than when broken is, I presume, due to the more rapid cooling of the ice when the space beneath it communicates with the open air, than when closed. H. F. P.

January 19

Clouds and Upper Wind-Currents over the Atlantic Doldrums

THE first of the two following weather sections across the Atlantic doldrums was taken in June and July last on board the s.s. *Tongariro*, during her voyage from Rio Janeiro to Teneriffe.

Practically clouds in these latitudes may be taken as belonging to three levels: a small cumulus, low down; a middle layer of some stratiform cloud; and a high-level cirrus. Any one of these may appear by itself, or all may be present simultaneously. The depth of the various air-currents which drive these clouds, I take to be of great importance in any general theory of the circulation of the atmosphere in the equatorial regions.

Space will not permit me to give here the details of each day's observations, but the results may be briefly stated thus: South of the equator, the low or middle clouds over the south-east trade, which we picked up in 10° S. lat., invariably came from some point to the right of the surface-wind, when you stood with your back to it, *i.e.* if the surface-wind was south-east the clouds would drive from about east-south-east. This is the usual rotation of upper currents in the southern hemisphere.

But, north of the Line, when for reasons which cannot be discussed here, the south-east trade did not turn to south-west, as might have been expected, the upper currents continued to follow the rotation of the southern, and not that of the northern hemisphere, that is to say, the upper currents over the south-east surface-wind continued to come from some more easterly point. In the "doldrums," also, which extended from about 8° to 13° N., the same rule obtained, and the middle cloud-layer over some "cat's-paws" of south-east wind drove from the east.

In the north-east trade I only got one unsatisfactory observation in 22° N., 19° W., which gave a middle layer of north-north-east wind over an east-north-east surface trade. This is contrary to what might have been expected.

The second section was taken in December last on board the s.s. *Drummond Castle*, during part of her voyage between Lisbon and Cape Town, with much better appliances for observing clouds than on my former voyage.

In the north-east trade, from 30° N. lat. down to the doldrums in 5° N., the upper layers of cloud invariably came from some point to the left of the surface-wind. When you stood with your back to it, *i.e.* if the surface-wind was from north-east, the higher clouds would come from east, or south-east, or even south by west. This is the usual rotation of upper wind-currents in the northern hemisphere. As far north as 20° N. the middle clouds came from south by west, and in 10° N. this current had descended to the level of the low cumulus, and the middle clouds drove from west.

But as we touched the doldrums in 5° N., a totally different wind-system became apparent. Over the oily calm of that district I could just detect, through the universal haze and gloom, a middle current from the east; and when, in a few hours, we picked up the south-west monsoon of the Gulf of Guinea, here coming from south by west, the low clouds drove from south-east. This continued till we reached the Line, and the single observation which I got of high cirrus in 1° N. lat. showed an easterly current at that level. Thus, for 8° N. of the equator the rotation of the upper winds was that proper to the southern hemisphere, for south-east and east were over a south-west surface-wind instead of west or north-west, as might have been expected. This is the more curious, because the surface-wind has the south-west set proper to the northern hemisphere.

But the greatest interest of this last observation is to be found in the extraordinary analogy which the wind-system over the Gulf of Guinea presents to the wind-system over the north-west monsoon in the Indian Ocean, which I discovered last spring, and described in a letter to NATURE of October 29, 1885 (p. 624). In that region I found that as the north-east monsoon crosses the Line and turns to the north-west, the upper currents are those proper to the northern hemisphere, that is to say the low and high layers of cloud come from north and east respectively. Now we see that both in the Gulf of Guinea and mid-Atlantic, as the south-east trade crosses the Line, it carries the rotation of the higher currents, proper to itself, up to the doldrums.

After crossing the equator in the *Drummond Castle* the wind turned to south by east or south-south-east, and as far as 18° S., beyond which we need not follow them, the upper currents were either identical in direction with the surface-wind, or else a very little more easterly—that is, they followed the normal rotation of their hemisphere.

In conclusion, I may point out another very important result of these observations as far as they have gone yet:—The highest current between the equator and the doldrums is always from some point near the east, whatever the westerly set of the surface-wind may be. I have had no opportunity of estimating the velocity of this current, but the impression on my mind has been that it is not apparently very rapid, though, of course, the height is very considerable. RALPH ABERCROMBY

Cape Town, December 18, 1885

Ventilation

HAVING read your late article on ventilation, and letters referring thereto, I think it may be of interest to your readers to know something of what we have done in this quarter. Since the year 1877 we have had in Dundee a number of schools and other buildings ventilated and heated by propelling large volumes of heated air into the rooms with a small-power engine.

The system, as now generally introduced, is as follows:—Rotary air-pumps, or a Blackman air-propeller, driven by a small gas-engine, are placed in the basement floor. The air is conducted thither by flues from an altitude of 30 feet, so as to be as free from dust and other impurities as possible. This cold air is discharged into large wooden flues under the ground floor, which are painted with asbestos paint. Running parallel to these flues are others containing hot-water high-pressure pipes, about $1\frac{3}{8}$ inches in diameter. These hot flues are divided into air-tight sections, suitable for the heating of the different rooms. The air from the cold flue passes into the different sections of the hot flue, from which again it passes out, heated, into the different rooms, about 5 feet from the floor, by long and narrow flues, so that it may be well diffused. Each room has its own exhaust-flue or flues, reaching within $1\frac{1}{2}$ feet of the floor, and passing into the space between the upper-floor ceiling and the roof. This space is made into a large flue, into which all the foul air from the different rooms passes. On the roof there are constructed one or more square shafts, with fixed louvre boards on each of the four sides. Inside the louvres are fixed valve-frames covered with a large number of light waterproof cloth valves, which prevent the air passing inwards. There are always one or more sides on which the wind does not blow, allowing the foul air free egress from within out. Some of the school buildings where this system has been introduced are having as much air passed through them as will refill the rooms every 10 or 15 minutes.

This system, as explained, can be seen in operation at the chemical laboratory of the Dundee University College, the Harris Academy, Dundee, and at the Dundee High Schools, the directors of which are introducing the system into another large new school for girls, which is to be opened in a few months. WILLIAM CUNNINGHAM

Dundee, January 12

A Family of Rare Java Snakes

AT the Zoological Gardens, on Saturday, the 9th inst., a rather rare "Green-Tree Snake" (*Dryiophis prasina*), from Java, produced eight snakelings under circumstances which tend to confirm recent observations regarding the uncertain period of gestation in snakes, otherwise the voluntary retention or deposition of their eggs or even their young. The mother was brought to the Reptilium five months ago (August 15), and allowing two months for her transportation from Java, it must be at least seven months since she was captured and separated from her mate. The normal period of gestation in a snake of this size may be about three months, but incubation, which begins at once, would in all snakes seem to depend a good deal on temperature and on other propitious circumstances; nor can it be positively asserted that such or such a species is invariably oviparous or viviparous, as in several instances the same snake has been known to be both—*i.e.* under certain conditions an oviparous snake has become viviparous. In sunny weather a high temperature is obtained in the cages where this snake is; and it is probable that the late cold season may have materially affected this *Dryiophis*. It is probable that, lacking the dense foliage of her native forests, together with these adverse conditions of her small glass dwelling, she retained her progeny until the latest moment.

The snakelings average 20 inches in length. The mother is over 5 feet, and like all the family of whip-snakes is exceedingly slender, with the long tail tapering to a cord-like fineness. She is of a bright emerald green, while the little ones are of a dull ashy hue, with tongues of the same colour; the mother's tongue is pinkish. The parent has fed well on small lizards during her captivity, but it is to be feared that the little family will fare badly, as at the present time suitable food is difficult to procure. They were at once removed into another cage, or their mother might have reduced their numbers at dinner-time. They soon found their way to the water-pan and drank freely, and began to cast their skins at an early day.

CATHERINE C. HOPLEY

15, Queen's Crescent, Haverstock Hill, N.W.

Vibration of Telegraph-Wires

I NOTICED to-day a curious vibration of telegraph-wires near here, and perhaps some reader of NATURE may be able to explain it. Each wire was vibrating rapidly, but instead of the nodes being only at each post, there were several in each span (of about 88 yards). The number of nodes varied in each span; I counted seven in one, nor did the wires vibrate together as a rule. In some spans four out of five wires were vibrating, and in others only one. The total amplitude of vibration did got exceed $1\frac{1}{2}$ inches, I should think. I noticed this peculiar action in some five or six contiguous spans only. There was a very hard frost at the time, and the wires were coated with snow which had fallen some thirty-six hours previously. There was no wind, and the sun was just breaking through a fog. The wire was galvanised iron, No. 8 B.W.G.

E. DE M. MALAN

Howden, East Yorkshire, January 19

HEREDITARY STATURE [1]

IT will perhaps be recollected that, at the meeting last autumn of the British Association in Aberdeen, I chose for my Presidential Address to the Anthropological Section a portion of the wide subject of "Hereditary Stature." My inquiries were at that time advanced only to a certain stage, but they have since been completed up to a well-defined resting-place, and it is to their principal net results that I shall ask your attention to-night.

I am, happily, released from any necessity of fatiguing you with details, or of imposing on myself the almost impossible task of explaining a great deal of technical work in popular language, because all these details have just been laid before the Royal Society, and will in due course appear in their *Proceedings*. They deal with ideas that are perfectly simple in themselves, but many of which are new and most are unfamiliar, and therefore difficult to apprehend at once. My work also required to be tested and cross-tested by mathematical processes of a very technical kind, dependent in part on new problems, for the solution of which I have been greatly indebted to the friendly aid of Mr. J. D. Hamilton Dickson, Fellow and Tutor of St. Peter's College, Cambridge. I shall therefore quite disembarrass myself on the present occasion from the sense of any necessity of going far into explanations, referring those who wish thoroughly to understand the grounds upon which my results are based, to the forthcoming memoir in the *Proceedings* of the Royal Society, and to that amplified and illustrated extract from my Address at Aberdeen, accompanied by tabular data, which appeared among the "Miscellanea" of the *Journal* of this Institute last November.

The main problem I had in view was to solve the following question. Given a group of men, all of the same stature, whatever that stature may be,—it is required to be able to predict two facts regarding their brothers, their sons, their nephews, and their grandchildren, respectively, namely, *first*, what will be their average height; *secondly*, what will be the percentage of those kinsmen whose statures will range between any two heights we may please to specify;—as between 6 feet and 6 feet 1 inch, 6 feet 1 inch and 6 feet 2 inches, &c.?

The same problem admits of another rendering, because whatever is statistically *certain* in a large number is the *most probable* occurrence in a small one, so we may phrase it thus: Given a man of known stature, and ignoring every other fact, what will be the most probable average height of his brothers, sons, nephews, grandchildren, &c., respectively, and what proportion of them will most probably range between any two heights we may please to specify?

I have solved this problem with completeness in a practical sense. No doubt my formulæ admit of extension to include influences of a minor kind, which I am content to disregard, and that more exact and copious observations may slightly correct the values of the constants I use; but I believe that for the general purposes of understanding the nearness of kinship in stature that subsists between relations in different degrees, the problem is solved.

It is needless to say that I look upon this inquiry into stature as a representative one. The peculiarities of stature are that the paternal and maternal contributions blend freely, and that selection, whether under the aspect of marriage selection or of the survival of the fittest, takes little account of it. My results are presumably true, with a few further reservations, of all qualities or faculties that possess these characteristics.

Average Statures.—The solution of the problem as regards the average height of the kinsmen proves to be almost absurdly simple, and not only so, but it is explained most easily by a working model that altogether supersedes the trouble of calculation. I exhibit one of these: it is a large card ruled with horizontal lines 1 inch apart, and numbered consecutively in feet and inches, the value of 5 feet 8 inches lying about half way up. A pin-hole is bored near the left-hand margin at a height corresponding to 5 feet $8\frac{1}{4}$ inches. A thread secured at

[1] Extracts from Mr. F. Galton's Presidential Address to the Anthropological Institute, January 26.

the back of the card is passed through the hole; when it is stretched it serves as a pointer, moving in a circle with the pin-hole as a centre. Five vertical lines are drawn down the card at the following distances, measured horizontally from the pin-hole: 1 inch, 2 inches, 3 inches, 6 inches, and 9 inches. For brevity I will call these lines I., II., III., VI., and IX. respectively. This completes the instrument. To use it: Hold the stretched thread so that it cuts IX. at the point where the reading of the horizontal lines corresponds to the stature of the given group. Then the point where the string cuts VI. will show the average height of all their brothers; where it cuts III. will be the average height of the sons; where it cuts II. will be the average height of the nephews; and where it cuts I. will be the average height of the grandchildren. These same divisions will serve for the converse kinships; VI., obviously so; III., son to a parent; II., nephew to an uncle; I., grandson to a grandfather. Another kinship can be got from VI., namely, that between "mid-parent" and son. By "mid-parental" height I mean the average of the two statures: (*a*) the height of the father, (*b*) the transmuted height of the mother. This process, I may say, is fully justified by the tables already printed in our *Journal*, to which I have referred. It is a rather curious fact that the kinship between a given mid-parent and a son should appear from my statistics to be of exactly the same degree of nearness as that between a given man and his brother. Lastly, if we transmute the stature of kinswomen to their male equivalents by multiplying them after they are reduced to inches, by 1·08, or say, very roughly, by adding at the rate of 1 inch for every foot, the instrument will deal with them also.

You will notice that the construction of this instrument is based on the existence of what I call "regression" towards the level of mediocrity (which is 5 feet 8¼ inches), not only in the particular relationship of mid-parent to son, and which was the topic of my Address at Aberdeen, but in every other degree of kinship as well. For every unit that the stature of any group of men of the same height deviates upwards or downwards from the level of mediocrity as above, their brothers will on the average deviate only two-thirds of a unit, their sons one-third, their nephews two-ninths, and their grandsons one-ninth. In remote degrees of kinship, the deviation will become zero; in other words, the distant kinsmen of the group will bear no closer likeness to them than is borne by any group of the general population taken at random.

The *rationale* of the regression from father to son is due (as was fully explained in the Address) to the double source of the child's heritage. It comes partly from a remote and numerous ancestry, who are on the whole like any other sample of the past population, and therefore mediocre, and it comes partly only from the person of the parent. Hence the parental peculiarities are transmitted in a diluted form, and the child tends to resemble, not his parents, but an ideal ancestor who is always more mediocre than they. The *rationale* of the regression from a known man to his unknown brother is due to a compromise between two conflicting probabilities; the one that the unknown brother should differ little from the known man, the other that he should differ little from the mean of his race. The result can be mathematically shown to be a ratio of regression that is constant for all statures. The results of observation accord with, and are therefore confirmed by, this calculation.

Variability above and below the Mean Stature.—Here the net result of a great deal of laborious work proves, as in the previous case, to be extremely simple, and to be very easily expressed by a working model. A set of five scales can be constructed, such as I exhibit, one appropriate to each of the lines I., II., III., and VI., and suitable for any position on these lines. They are so divided that when the centres of the scales are brought opposite to the points crossed by the thread, in the way already explained, we shall see from the divisions on the scales what are the limits of stature between which successive batches of the kinsmen, each batch containing 10 per cent. of their whole number, will be included. Smaller divisions indicate the 5 per cent. limits. The extreme upper and extreme lower limits are perforce left indefinite. Each of the scales I give deals completely with nine-tenths of the observations, but the upper and lower 5 per cent. of the group, or the remaining one-tenth, have only their inner limits defined.

The divisions on the movable scales that are appropriate to the several lines VI., III., II. and I., are given in the table, where they are carried one long step further than I care to recommend in use.

Per-cents. of included statures	Divisions, upwards and downwards, from centres of the scales; in inches		
	VI.	III.	II. and I.
10	0·5	0·6	0·6
20	1·0	1·3	1·3
30	1·6	2·0	2·1
40	2·4	3·0	3·1
45	3·1	3·9	4·0
49·5	4·8	6·1	6·3

The divisions are supposed to be drawn at the distances there given, both upwards and downwards from the centres of the several scales, which have to be adjusted, by the help of the thread, to the average height of the kinsmen indicated in the several lines. The percentage of statures that will then fall between the centre of each scale and the several divisions in it is given in the first column of the table. Example:—In line VI. 40 per cent. will fall between the centre and a point 2·4 inches above it, and 40 per cent. will fall between the centre and a point 2·4 inches below it; in other words 80 per cent. will fall within a distance of 2·4 inches from the centre. Similarly we see that 2 × 49·5, or 99 per cent. will fall within 4·8 inches of the centre.

In respect to the principle on which these scales are constructed, observation has proved that every one of the many series with which I have dealt in my inquiry conforms with satisfactory closeness to the "law of error." I have been able to avail myself of the peculiar properties of that law and of the well-known "probability integral" table, in making my calculations. A very large amount of cross-testing has been gone through, by comparing secondary data obtained through calculation with those given by direct observation, and the results have fully justified this course. It is impossible for me to explain what I allude to more minutely now, but much of this work is given, and more is indicated, in the forthcoming memoir to which I have referred.[1]

I know of scarcely anything so apt to impress the imagination as the wonderful form of cosmic order expressed by the "law of error." A savage, if he could understand it, would worship it as a god. It reigns with serenity in complete self-effacement amidst the wildest confusion. The huger the mob and the greater the apparent

[1] The following will be of help to those who desire a somewhat closer idea of the reasoning than I can give in a popular Address.

m = mean height of race = 68·25 inches.

$m \pm x$ = height of a known individual.

$m \pm x'$ = the probable height of an unknown kinsman in any given degree.

$\frac{x'}{x}$ (which I designate by w) = the ratio of mean regression: it is shown by direct observation to = $\frac{2}{3}$ both in the case of mid-parent to son, and of man to brother; it is inferred to be $\frac{1}{3}$ in the case of parent to son. It is upon these primary kinships that the rest depend.

The "probable" deviations ("errors") from the mean values of their respective systems are—

p = that of the general population = 1·70 inch.

b = that of any large family of brothers = 1·0 inch.

f = that of kinsmen from the mean value of $m \pm x'$.

Since a group of kinsmen in any degree may be considered as statistically identical with a sample of the general population, we get a general equation that connects f with w, namely, $w^2p^2 + f^2 = p^2$.

The ratio of regression in respect to brothers can be shown to depend on the equation $w = \frac{p^2 - b^2}{p^2} = \frac{2}{3}$ nearly.

anarchy the more perfect is its sway. Let a large sample of chaotic elements be taken and marshaled in order of their magnitudes, and then, however wildly irregular they appeared, an unsuspected and most beautiful form of regularity proves to have been present all along. Arrange the statures side by side in order of their magnitudes, and the tops of the marshaled row will form a beautifully flowing curve of invariable proportions; each man will find, as it were, a preordained niche, just at the right height to fit him, and if the class-places and statures of any two men in the row are known, the stature that will be found at every other class-place, except towards the extreme ends, can be predicted with much precision.

It will be seen from the large values of the ratios of regression how speedily all peculiarities that are possessed by any single individual to an exceptional extent, and which blend freely together with those of his or her spouse, tend to disappear. A breed of exceptional animals, rigorously selected and carefully isolated from admixture with others of the same race would become shattered by even a brief period of opportunity to marry freely. It is only those breeds that blend imperfectly with others, and especially such of these as are at the same time prepotent, in the sense of being more frequently transmitted than their competitors, that seem to have a chance of maintaining themselves when marriages are not rigorously controlled—as indeed they never are, except by professional breeders. It is on these grounds that I hail the appearance of every new and valuable type as a fortunate and most necessary occurrence in the forward progress of evolution. The precise way in which a new type comes into existence is untraced, but we may well suppose that the different possibilities in the groupings of some such elements as those to which the theory of pangenesis refers, under the action of a multitude of petty causes that have no teleological significance, may always result in a slightly altered, and sometimes in a distinctly new and fairly stable, position of equilibrium, and which, like every other peculiarity, admits of hereditary transmission. The general idea of this process is easy enough to grasp, and is analogous to many that we are familiar with, though the precise procedure is beyond our ken. As a matter of fact, we have experience of frequent instances of "sports," useful, harmful, and indifferent, and therefore presumably without teleological intent. They are also of various degrees of heritable stability. These form fresh centres, towards which some at least of the offspring have an evident tendency to revert. By refusing to blend freely with other forms, the most peculiar "sports" admit of being transmitted almost in their entirety, with no less frequency than if they were not exceptional. Thus a grandchild, as we have seen, regresses on the average one-ninth. Suppose the grandfather's peculiarity refused to blend with those of the other grandparents, then the chance of his grandson inheriting that peculiarity in its entirety would be as one to nine; and, so far as the new type might be prepotent over the other possible heritages, so far would the chance of its reappearance be increased. On the other hand, if the peculiarity did not refuse to blend, and if it was exceptional in magnitude, the chance of inheriting it to its full extent would be extremely small. The probability (easily to be calculated for any given instance by the "probability integral" tables) might even be many thousand times smaller. I will give for an example a by no means extreme case. Suppose a large group of men, all of 6 feet 5 inches in height, the statures of whose wives are haphazard, then it can be shown that out of every thousand of the sons not more than one on an average will rival or surpass the height of his father. This consideration is extremely important in its bearing on the origin of species. I feel the greatest difficulty in accounting for the establishment of a new breed in a state of freedom by slight selective influences, unless there has been one or more abrupt changes of type, leading step by step to the new form.

It will be of interest to trace the connection between what has been said about hereditary stature and its application to hereditary ability. Considerable differences have to be taken into account and allowed for. *First*, after making large allowances for the occasional glaring cases of inferiority on the part of the wife to her eminent husband, I adhere to the view I expressed long since as the result of much inquiry, historical and otherwise, that able men select those women for their wives who on the average are not mediocre women, and still less inferior women, but those who are decidedly above mediocrity. Therefore, so far as this point is concerned, the average regression in the son of an able man would be less than one-third. *Secondly*, very gifted men are usually of marked individuality, and consequently of a special type. Whenever this type is a stable one, it does not blend easily, but is transmitted almost unchanged, so that specimens of very distinct intellectual heredity frequently occur. *Thirdly*, there is the fact that men who leave their mark on the world are very often those who, being gifted and full of nervous power, are at the same time haunted and driven by a dominant idea, and are therefore within a measurable distance of lunacy. This weakness will probably betray itself in disadvantageous forms among their descendants. Some will be eccentric, others feeble-minded, others nervous, and some may be downright mad.

It will clear our views about hereditary ability if we apply the knowledge gained by our inquiry to solve some hypothetical problem. It is on that ground that I offer the following one. Suppose that in some new country it is desired to institute an Upper House of Legislature consisting of life-peers, in which the hereditary principle shall be largely represented. The principle of insuring this being that two-thirds of the members shall be elected out of a class who possess specified hereditary qualifications, the question is, What reasonable plan can be suggested of determining what those qualifications should be?

In framing an answer, we have to keep the following principles steadily in view:—(1) The hereditary qualifications derived from a single ancestor should not be transmitted to an indefinite succession of generations, but should lapse after, say, the grandchildren. (2) All sons and daughters should be considered as standing on an equal footing as regards the transmission of hereditary qualifications. (3) It is not only the sons and grandsons of ennobled persons who should be deemed to have hereditary qualifications, but also their brothers and sisters, and the children of these. (4) Men who earn distinction of a high but subordinate rank to that of the nobility, and whose wives had hereditary qualifications, should transmit those qualifications to their children. I calculate roughly and very doubtfully, because many things have to be considered, that there would be about twelve times as many persons hereditarily qualified to be candidates for election as there would be seats to fill. A considerable proportion of these would be nephews, whom I should be very sorry to omit, as they are twice as near in kinship as grandsons. One in twelve seems a reasonably severe election, quite enough to draft off the eccentric and incompetent, and not too severe to discourage the ambition of the rest. I have not the slightest doubt that such a selection out of a class of men who would be so rich in hereditary gifts of ability, would produce a body of men at least as highly gifted by nature as could be derived by ordinary parliamentary election from the whole of the rest of the nation. They would be reared in family traditions of high public services. Their ambitions, shaped by the conditions under which hereditary qualifications could be secured, would be such as to encourage alliances with the gifted classes. They would be widely and closely connected with the people, and they would to all appearance—but who can speak with certainty of the effects of any paper constitution—form a vigorous and effective aristocracy.

DEPOSITS OF THE NILE DELTA

IN a previous communication I referred to the probability that the lower portion of the Delta borings belongs to the Pleistocene and Isthmian deposit which underlies the modern Nile mud, and which has been recognised as an important formation by nearly all geologists who have studied the Nile Valley. I now propose to state shortly some objections to the generalisations of the Report on the Nile borings with reference to the causes assigned for the comparative purity of the waters of the Nile, and the character of its sediment, viz. that the former is due to its flowing through a rainless country, and that the latter is derived from the decay of rocks in this rainless area, and this decay produced not by "chemical agencies," but by "mechanical forces," namely, the "unequal expansion" of the constituent minerals under the influence of heat and cold, aided by "the force of the wind."

It is scarcely necessary to premise that neither the water nor the mud of the Nile can be derived from the rainless district through which the river flows, but from the well-watered regions of interior Africa. The White Nile, which carries scarcely any sediment, is a somewhat constant stream, draining a country of lakes, swamps, and forests. The Blue or Dark Nile and the Atbara drain the mountainous country of Abyssinia, deluged with rain in the wet season, and it is these streams, swollen by violent inundations, that supply the Nile with its sediment, the quantity of fresh material carried into the river below the confluence of the Atbara being very small, as the results of the microscopic study of the sediment sufficiently proves, and I can testify from my own examinations of the Nile mud, that its composition, as stated by Prof. Judd, is essentially the same along the course of the Nile as in the upper layers of the Delta borings, though with some local differences in the fineness of the sand and the proportion of argillaceous matter. Thus both the water of the inundations and the material of the alluvial deposit come from a region of copious rains, and where decay of rocks may be supposed to proceed under the ordinary conditions.

What then is the cause of the freedom of the Nile water from saline matter? Simply its derivation from a country of siliceous and crystalline rocks. If, instead of comparing it with the water of the Thames and other streams draining sedimentary districts, it had been compared with that of the lakes and streams of the Scottish Highlands (by no means rainless districts) this would have been apparent. Dr. Sterry Hunt has described and referred to its true cause a fact of the same kind in the case of the Ottawa and St. Lawrence. The former, rising in a region of crystalline rocks, has little more than one-third of the saline matter in solution that is found in the latter, which drains principally a sedimentary country. The proportions in 10,000 parts are, for the Ottawa, only 0·6116, and for the St. Lawrence, 1·6055.[1]

But it may be asked, Why in that case is the Nile mud so deficient in kaolin? The answer is, that the current of the river is sufficiently strong to wash out all the more finely comminuted argillaceous matter and to carry it in its turbid waters to the sea. In connection with this, every voyager on the falling Nile must have observed how the mud-banks are constantly falling as they are undermined by the river, and their material carried down to be redeposited. This work goes on even more energetically in the time of the inundations. Thus any given quantity of sediment on its way from Abyssinia to the Delta is lixiviated thousands of times, and necessarily deprived of its lighter and finer constituents.

But the quantity of kaolin need not originally have been large. The older gneisses and schists do not kaolinise after the manner of Cornish granites, but, when decomposed so as readily to crumble into sand, they still contain much of their more refracting felspar in a perfect state.

These facts are farther illustrated by the agricultural qualities of the Nile alluvium, as they have been explained by Schweinfurth and others. If the alluvial soil were a stiff clay, it would be practically incapable of cultivation in the circumstances of Egypt. If it were mere quartzose sand, it would be hopelessly barren. It is, in fact, an impalpable sand, highly absorbent of water, crumbling readily when moistened, and containing not merely quartz but particles of various silicates and of apatite and dolomite, which, though unaltered when under water, are gradually dissolved by the carbonic acid present in the cultivated soil, yielding alkalies, phosphates, &c., to the crops. In connection with this, recent microscopic examinations by Dr. Bonney of the old crystalline rocks of Assouan, which are probably similar to those farther north, show that, like those of Canada and Norway, they contain numerous crystals of apatite.

As to the mechanical action of the heat of the sun on crystalline rocks, any one who examines the polished surfaces still retained by monuments which in Upper Egypt have been exposed to this influence for thousands of years, must be convinced that no disintegration of this kind occurs. The only evidence of such actions that I have been able to find is the chipping of little circular disks from the exposed sides of nodules of flint on the surface of the desert. Granitic rocks decay, however, in Egypt, as elsewhere, where they are exposed to moisture from the soil, or where, as at Alexandria, they are subjected to the influence of frequent rains and of saline particles carried from the sea. In this connection I may add that Hague, in a paper in *Science* on the decay of the New York obelisk, shows that it had probably suffered (as, according to Wigner, that in London has also done) from atmospheric action before its removal from Alexandria, and that this decay has been greatly increased by the alternations of moisture and frost to which it is subjected in New York.[1]

At Assouan, in a climate at present rainless, or nearly so, I was surprised to find that the surface of the gneiss and crystalline schists was in many places decayed to the depth of several feet, so that it was impossible to obtain fresh specimens except from the railway cuttings. This may be due to the action of water and carbon dioxide oozing through the ground, but is more probably a result of more humid climatal conditions in former ages.

I hope at a future date to pursue these interesting questions farther; but in the meantime I shall be content if it has been shown that Egypt owes the advantage of pure, sweet water to the fact that it drinks of mountain streams which the rainless character of its own climate merely preserves from pollution by the drainage of the Cretaceous and Tertiary beds, and that its rich alluvial soil has not been produced by any mechanical action of an exceptional nature, but by the ordinary atmospheric agencies of denudation.

These conclusions, as well as those stated in my previous letter, respecting the depth of the modern alluvium and its relation to the well-known Pleistocene formation which underlies it, could be confirmed by the testimony of most geologists who have studied the valley of the Nile, and more especially of Lartet, Fraas, and Schweinfurth. I hope that as now stated, however imperfectly, they may suffice to induce the Committee materially to modify its Report, or to postpone its publi-

[1] Logan's "Geology of Canada," 1865, p. 565.

[1] The freezing of water in the pores of rocks is undoubtedly an important cause of destruction in the colder climates.

cation until those members of the Royal Society who have studied the geology of Egypt can have opportunity to discuss it fully. J. WILLIAM DAWSON

December 28, 1885

NOTES ON THE "MUIR GLACIER" OF ALASKA

IN a recent number of NATURE (vol. xxxii. p. 162) an abstract is made of a San Francisco newspaper account of the "Great Glacier" of Alaska. This account is not very accurate, and as I spent a few hours on this glacier during a flying visit to Alaska in the summer of 1884, I think my observations may be worth recording. I have heard that some descriptions by American observers have already been published, but have not been able to procure them. However, as there are one or two features to which it may be useful to draw the attention of future explorers in this region, I will give my observations just as I made them, and apologise beforehand if they should be found to overlap those of others.

On August 1, 1884, I took passage from Victoria, Vancouver Island, on the steamer—on this occasion the *Ancon*—which carries the monthly mail from ports on Puget Sound to Sitka, Alaska, and eight days later we steamed up the long fiord known as "Glacier Bay," which opens into the Chilcoot Inlet, being then not far from latitude 59° N. and longitude 136° W. of Greenwich.

On either side of us high snow-capped mountains bordered the fiord, and in their recesses we could see glaciers of all sizes. One large mass filled a deep valley on our left, and reached nearly down to the sea, being apparently only separated from it by a ridge of moraine; and everywhere little patches of blue rested in all the *coulées* near the mountain-tops, and showed by their trail of bare striated rocks and long strings of moraine how much further they must recently have extended.

Here and there a small island rose above the waters of the fiord, and, by its bare rounded outline and *moutonnéed* surface, gave evidence that it, too, had once been overspread by the ice. The Indians say that one of these islands which is now above a mile distant from the Great Glacier, was embedded in the ice during their recollection, and I was told that early Russian charts of the coast do not show this fiord at all, but make note of a line of ice cliffs near its present entrance; but though the fiord has undoubtedly been at one time filled with ice, I cannot think that the period was so recent as this would indicate.

All round us the waters of the bay were strewn with masses of floating ice of beautiful colour and fantastic outline, but none were large. Right ahead, a gleaming wall of ice rose up out of the water and completely blocked the fiord, extending with a slight outward bulge from shore to shore. This was the "Great Glacier," or the "Muir Glacier," of Alaska.

In the account in NATURE it is stated that the height of the ice-wall is 500 feet, but I think this is an exaggeration. The master of our steamer thought its highest point might reach 450 feet; my own estimate would place it much lower even than this. Where I stood beneath it on the eastern shore I do not think it was more than 240 feet high, judging from the better-known height of an abutting cliff of sand and gravel presently to be described; but as the upper surface of the glacier appeared to be slightly domed, so as to be highest in the centre of the bay and lowest near the mountains, I should say that near the middle of the fiord the cliffs might be nearly 100 feet higher than where I stood; but in my opinion they nowhere exceeded 350 feet.

The breadth of this ice-wall was about three miles. Huge masses were constantly splitting from it and sliding down into the sea with a loud dull roar. As they slid they raised a white dust-like cloud, and when they fell into the water great waves leaped in upon them and dashed high up the ice cliff, rebounding and causing every now and again a broad deep ground-swell which we could watch as it rapidly swept towards us.

The water through which we passed had changed when we first entered the fiord from the deep dark blue of the outer channel to a beautiful pale green, and now became quite clouded and of a milky greenish-white; and when we came nearer the glacier strong springs were observable, bursting up through the sea-water so as to rise slightly above its level. These were some little distance from the ice-cliff, which must have projected forward under water.

After having failed in an attempt to make fast to a grounded mass of ice—the largest near us—which rose up in pinnacles to the height of our somewhat stunted topmasts, we anchored near the right, or eastern, shore. Our party was then put ashore on a fine beach of washed sand and shingle, about half a mile from the foot of the glacier.

This beach is formed by the action of the waves on a mass of morainic material which is piled up irregularly between the shore and the bare mountain-side, and, where we landed, sloped back almost insensibly into the glacial gravels. But nearer the glacier the moraine had been cut back so as to form a low cliff, which increased in height as it approached the ice.

This cliff exhibited a clear and very interesting section, of which I made a sketch on the spot, shown in Fig. 1.

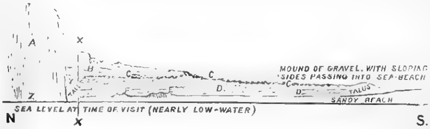


FIG. 1.—Sketch Section of Cliff at the head of Glacier Bay, Alaska, on the eastern shore, adjoining the glacier, Aug. 9, 1884. Length of section about 400 yards; height at X about 100 feet.

A, Eastern end of terminal precipice of Muir Glacier, a nearly vertical wall of very clear blue ice, without stones: the ice shows lines of bedding towards the base, which are strongly curved over a dome-shaped cave (*z*) from which issues a strong current of muddy water; this cave is filled by the sea at high tide; full height of ice wall, which is about 240 feet here, is not shown.

B, Flange of very stony, dirty ice, apparently descending and flowing forward from the main mass of the glacier at a point some distance behind the line of section: about 60 feet thick at *X*....*X*: this passes over the sands and gravels D, and covers them for some distance, but rapidly diminishes in thickness, and seems to fade away into the *remainder-bed* C.

C, Rubble of angular and water-worn boulders and pebbles mixed with sand and clay; derived from the melting of the stony ice, B, whose lower layers are scarcely distinguishable from this bed.

D, Steep cliff of evenly-bedded sand and gravel; pebbles small and water-worn; shows signs of erosion at junction with C, but the bedding is not disturbed: height at *X*.....*X* 40 feet.

E, A small boss of stony, bluish-gray clay resembling till, outcropping below the sands and gravels: full of small water-worn pebbles.

F, Similar boss of fine gray clay without stones: no observable bedding.

NOTES.—In the above figure that part of the section marked A is not on the same plane as the rest, which recedes about 20 yards—the width of the sea-beach.

A narrow gully (*y*) had been excavated between A and D by water derived from the melting ice, and the lower part of the section was here obscured by talus: C crossed the head of this gully and joined the main mass of the glacier, but it was difficult to study this junction, as the ice of C overhung the gully, and was constantly shedding masses into it.

The size of the patches of clay marked E and F is somewhat exaggerated in the section to make them apparent. I saw only a small surface of each rising above the beach in the cliff-foot; but from the manner of their outcrop I think they may form part of a clayey base on which the gravels rest.

I was not able to give much time to the study of this remarkable section, but was able to satisfy myself on the following points:—That a considerable thickness of *evenly-bedded*, water-worn gravel and sand was in close proximity to an almost vertical wall of ice, if not actually abutting on it. That this bedded gravel and sand was covered for some distance by a mass of dirty ice, full of stones, which was connected in some way with the main mass of the glacier. That the bedding of this deposit was in no way disturbed by either of these masses of ice. That a loose unstratified deposit containing both angular and water-worn pebbles and a little clay and sand, evidently the remainder-beds from the melting of the dirty and stony ice, overlay the bedded gravels. And that fine grey clay, in one place with stones, in another without, resembling glacial clays with which I am well acquainted, occurred below the bedded gravels.

A gentleman on board the steamer, Captain H. E. Morgan, of Port Townsend, W.T., with whom I had become acquainted during the voyage, had made several previous visits to the glacier; and we agreed to set out together for its upper surface as soon as we landed, and go as far along it as we could in the time allowed us.

We therefore struck out at once for the top, and, skirting the heaps of moraine which fill a large hollow space caused by the shrinking of the glacier from the mountain-side, we soon commenced to ascend, passing diagonally along steep slopes of what looked like rough gravel, but was really stony ice covered with a thick crust of loose stones, as some dark water-pools and narrow crevasses soon showed.

Along these slopes we rose rapidly for some distance, the rubbly covering becoming thinner and thinner, till we emerged on a tolerably even plane of clear dark ice, with a rough and evidently rapidly-wasting surface which afforded excellent foothold.

I should think we were now at least half a mile from the mountain-side, and this space was altogether occupied by moraine or moraine-covered ice. Our elevation would be about that of the end of the glacier—350 feet above sea-level. In front of us the surface rose rather steeply for another mile or so.

Up this slope we moved, following a course nearly parallel with the broad moraine on our right, which we had just crossed. On our left, at some distance from us, we could see another well-marked train of moraine, in which were many blocks of large size. The ice we were now passing over was very clear and unencumbered with debris, and of a magnificent pale blue tint. It was fissured transversely by deep crevasses, which, however, were not very wide, so that we could generally find a place to cross without diverging far from our course, though they seemed to widen as they left the margin of the glacier.

We went on in the same direction till we reached the crest of the slope. Up to this point I do not think the glacier anywhere exceeded a width of three miles, but now in front of us there lay a great expanse of ice which spread out like a lake, having a width which we estimated to be from six to eight miles. It seemed to me that from where we stood we looked slightly downward upon this basin. Numerous feeders poured into it on either side, one very large tributary coming in from a deep valley on our right about three miles distant, but its main gathering grounds were on some mountains at the head of the valley, which we estimated were about forty miles distant, our estimate being based on their appearance as compared with that of those off the mouth of the inlet, whose distance was known.

This basin discharged itself into the fiord by the steep slope we had just passed, which no doubt represented a similarly narrowed and increased slope in the buried valley beneath it. Our elevation here was probably not far short of 1000 feet. About three miles ahead of us an island of whitish rock cropped high up above the surface of the ice. This seemed to cause an eddy, as it were, in the current, there being a swerving of the ridges of ice on either side and a depression under its lee.

After passing the crest we found that the crevasses were no longer open, their sides coming together at a short distance below the surface, so as to form deep V-shaped troughs, or wells, which were filled with water of brilliant purity. The exquisite tints of blue deepening with the depth of the water exhibited by these ice pools made them a most beautiful spectacle. At the same time the surface of the glacier became very hummocky, so as to resemble a short cross-sea suddenly frozen, but as the decaying upper layer still afforded excellent foothold, and as there were now no black, open gulfs to startle one, travelling, though laborious, was quite practicable in any direction. We therefore changed our course and, striking out diagonally, soon crossed the narrow moraine on our left. This, which would be about a mile from the edge of the ice, we found to consist chiefly of blocks of gray granite of all sizes, mixed with much sand formed by the decomposition of the small boulders which had often crumbled away into little heaps of grit. Beyond this there did not seem to be any rocky debris on the ice nearer than the moraines of the opposite shore, and the glacier consisted entirely of clear massive ice cut up into grooves and ridges. I noticed here and there amongst this clear ice, however, patches of small extent through which a muddy yellow stain was suffused. Seeking a cause for this, I found in the midst of one of these patches a pasty-looking mass of gritty matter of the colour of rusted iron, forming a centre from which the stain had evidently diffused itself through the ice.

As this was not only far away from the moraine, but was also widely different from anything I had seen there, and as it did not in any way resemble an organic growth, I concluded that it might be of meteoric origin, and brought part of the mass away with me.

With the kind assistance of Mr. G. Carr-Robinson, F.R.S.E., F.C.S., I have lately been able to make a rough qualitative analysis of this substance, which has shown it to consist in great part of iron oxide, with a trace of nickel, and my suspicion that it may be a decomposed meteorite has thus been considerably strengthened. A more complete analysis will shortly be made. I hope that some future visitor to the locality will more thoroughly investigate this point, and carefully examine any stained ice which he may meet with in the body of the glacier. I took hasty notice of several instances, but only found this substance in the one case mentioned. A melting glacier of great age is certainly a likely place to reveal meteorites.

Capt. Morgan told me that once before when he was on the glacier he had come across the weathered bones of a bear protruding from the ice; he afterwards showed me one of the teeth which he had brought away with him.

After going a little further we found it was high time to return to the ship. There was now nearly two miles of ice and moraine between us and the mountain-side which bounded the glacier on our right, whilst on our left the ice still rose before us in broken hummocky ridges, with deep pools between. I pressed on alone to the crest of one of the ridges ahead of us, which promised a more extended view. Looking forward from this point, the surface seemed to become more and more broken, but I still could not see any open crevasses, and think it might have been possible to cross the glacier.

I then hurriedly retraced my steps, but instead of going directly back to the beach, swerved to the left, and passed down into the hollow between the glacier and the mountain-side to which I have already referred, wherein was heaped a great mass of moraine. This consisted chiefly of sand and gravel piled up in long ridges running roughly parallel with the flank of the glacier and with each other, with here and there a dangerous slough of soft tenacious mud between them, deposited by waters welling up from below. These ridges, of which there were three or four between the glacier and the mountain, were from 30 to 100 feet high, and were steeper on one side than the other; they seemed to contain both water-worn and angular pebbles, with a thin scattering of large blocks. I crossed two of them, but had not time to go further. To all appearance they were made up altogether of morainic matter, but in ascending the steep side of one of them I was surprised to find that my feet, after sinking through a few inches of loose stone, struck upon a hard surface of ice, and that the bulk of the ridge was made up of stony ice.

Seeing also that muddy water was welling out in the depression between this ridge and the next, I came to think that a buried portion of the glacier probably still underlay all this ground, perhaps even reaching down to the beach. Then, observing huge piles of similar material on the mountain-side, I concluded that a portion of the ice might remain hidden there also.

If this were so, then the downward pressure of this mass on the one hand against the sloping and partially-buried flank of the glacier on the other would readily explain the presence of these ridges.

This view of their origin is illustrated in the following diagram (Fig. 2), which I drew just after leaving the glacier; it would account for the mixture of water-worn and angular debris in the ridges, the former resulting from the watercourses between the glacier and the mountain, and the latter from the melting of stony ice.

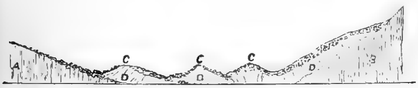


FIG. 2.—Ideal Section across the Moraine on the eastern flank of the Muir Glacier.
A, Eastern slope of the glacier: stony ice covered with a deep layer of loose stones.
B, Solid rock of the mountain-side.
C C C, Ridges apparently consisting of water-worn gravel and sand, with some angular debris, but probably hiding a core of stony ice, D D.
D D D, Buried portion of the glacier, supposed to exist below the moraine at C C C, and also on the mountain-side, which has been pressed up into ridges.

The ridges at the time of my visit were about half a mile in length, but may of course grow much longer as the glacier shrinks back. Though more or less regular, they were here and there interrupted and confused so as to form hollows surrounded by mounds, and in one case I noticed that the drainage of a gully had been dammed back so as to form a pond, in which the muddy water deposited much of its fine rock-flour, and issued out comparatively clear at the other side of the obstruction.

The boulders and pebbles of the moraine were chiefly of gray granite, but I noticed also quartzite, gneiss, a few fragments of slaty shale, and a mass of ancient-looking conglomerate—the last-named on the beach. During the day I saw only one scratched block; this was low down on the moraine near the beach.

We were now obliged to join the boat, which was waiting to take us back to the ship, and very much did I regret that circumstances would not permit me to stay longer.

Before leaving the ice-cliffs we fired a shot or two from our small signal cannon, to try to bring about an avalanche, but it had no perceptible effect, and the avalanches continued to choose their own time to fall.

This whole region forms a magnificent field for the study of glacial phenomena, and to any geologist who may follow I would especially say—examine the hollow between the ice and the mountains; go to the foot of the ice-cliff at low water; and, wherever there is stained ice on the top of the glacier, trace out the source of the discolouration. G. W. LAMPLUGH

NOTES

THE honour of knighthood was conferred upon Prof. Robert Stawell Ball, LL.D., Astronomer-Royal for Ireland, at the *levée* of the Lord-Lieutenant, on January 25.

LORD IDDESLEIGH has selected Mr. D. Morris, Director of the Public Gardens, Jamaica, for the appointment of Assistant Director of the Royal Botanic Gardens at Kew.

DR. RILEY, Entomologist to the United States Agricultural Department, has presented his collection of insects to the United States. It is said to contain 115,000 specimens of 20,000 species or varieties of insects.

THE Committee of the François Arago centenary have appointed M. Mouchez, Director of the Observatory, President; M. Floquet, President of the Chamber of Deputies, has been appointed Honorary President. The principal part of the celebration will take place at the Observatory.

M. PAUL BERT will not leave Paris so soon as was expected for Tonquin; the delay is occasioned by the organisation of the scientific part of his mission.

THE late M. Bertillon has bequeathed a sum of 4000 francs to the Paris Anthropological Society, to found a biennial prize to be awarded for the best work on some anthropological subject.

A SHOCK of earthquake was felt at about 7 o'clock on the morning of January 20 at St. Austell and in the neighbourhood. It appeared as if an explosion had taken place, so great was the noise, and the sound was immediately followed by the shaking of the ground. Persons felt their beds moving under them, and many others had an impression that a portion of their house was falling down. The shock was also felt at Mevagissey. Many people were shaken in their beds. In one instance a clock was stopped, and in many houses the doors and windows shook violently. The inhabitants of St. Blazey and neighbourhood were greatly startled, about a quarter past 7, by hearing a loud rumbling noise and by houses being shaken from foundation to roof. It appeared to come from a northerly direction, and the vibration lasted about 4 or 5 seconds. Persons coming in from the outlying districts and giving an account of the shock being more or less severe all agree as to the time of its taking place.

A TELEGRAM from Mexico states that there was a renewed eruption on January 16 from the Colima volcano. Enormous stones were thrown out, and great streams of lava appeared. The eruption was accompanied by earthquakes.

MR. J. FRANCIS COLE, writing from Sutton, Surrey, informs us that he was a spectator of the remarkable meteor alluded to in our columns of the 21st inst. (p. 278). As seen by him, the meteor appeared to explode or extinguish itself at a point about midway between the horizon and Capella, and was of a form like a well-shaped pear. It seemed so near that he felt he could have hit it with a stone. At the moment of exploding it opened in the centre of the lower part with a well-defined slit, and then widening, showed a light of the character of a hydrogen flame. The direction of the meteor was clearly from west to east, and at the same time the wind was blowing strongly from the west.

AMONGST the objects of interest at the forthcoming Colonial and Indian Exhibition will be a rare collection of indigenous Australian grasses. The specimens are named to correspond with the nomenclature used in the "Flora Australiensis," and there is in addition much practical information about each, derived from general sources.

WE have received Prof. Baird's last Report on the work of the Smithsonian Institution, which deals only with the half year ending June 30 last, in consequence of a resolution of the Board of Regents directing that the fiscal year, instead of extending from January to December, shall, like the Government fiscal year, extend from July 1 to June 30 in future. Amongst the publications promised by the Institution we notice the scientific writings of Prof. Joseph Henry, which will consist altogether of 1050 printed pages, and which are due now; also a work by Prof. Cope, of Philadelphia, on the reptiles and batrachians of North America. A compact manual on this subject was wanting, although numerous monographs on reptiles have been published, and when this has been completed, the entire field of the vertebrates of North America will have been covered by convenient and effective text-books prepared under the direction of the Institution. The various departments of the museum are treated, as usual, in successive paragraphs describing their work for the year. Under the head of "Explorations" we notice that Mr. Thomas Wilson, United States Consul at Nantes, and afterwards at Nice, has presented a very large collection of the remains of prehistoric man around these two places. It is believed that this collection, filling a large number of boxes, will prove to be one of the richest and most complete ever sent to the United States.

THE idea of an International Exhibition at Geneva has been abandoned, and it is now intended to hold only a national Swiss Exhibition.

A SOUTH AMERICAN Exhibition will be held at Berlin by the Central Verein für Handelsgeographie during May, June, and July, in which Brazilian products will be specially represented.

IN Germany an unusual number of white varieties of animals are noticed this winter. A white chamois was shot in the Totengebirge, a white fish otter was caught near Luxemburg, white partridges were shot near Brunswick, and a white fox was killed in Hessen.

THE recently-formed Central-Swiss Geographico-Commercial Society at Aarau is collecting funds for the erection of an ethnological museum.

IN the new number (No. 15) of the *Journal* of the Straits Branch of the Royal Asiatic Society, Mr. Wheatley, in a paper on the rainfall of Singapore, urges that the Straits Settlements are almost the wealthiest of the British colonies, and that it is not too soon to provide for an Observatory under an astronomer and meteorologist. The equatorial position of Singapore, he adds, would give to the astronomer a more interesting field for observation than can be obtained at higher or lower latitudes. Meanwhile, private observers are doing their best to study the meteorological features of the Straits, and Mr. Wheatley publishes tables of mean annual rainfall and number of rainy days from 1869 to 1884. Mr. Dodd, whose name is given to a conspicuous mountain-range in Northern Formosa, and who has already written on the "aborigines" of that island, describes the hill-tribes in the north, occupying the savage forest-clad mountains to the south-east and south of the town of Banka. These appear to have no negro features whatever; the hair is lank, not curly or frizzled, their lips are not so thick even as those of Malays, and the high noses possessed by many approach often the European type. The complexion, too, of the younger men who had not undergone much hardship or exposure is as light and fair as that of the Japanese. The paper is not finished in this number. The other papers are mainly geographical.

IN a recent paper to the *Archiv für Anthropologie* on the capacity and chief diameters of the skull in different nations, Herr Welcker considers that nine-tenths of all the figures of capacity given in literature are incorrect, most of them being excessive. After discussing different modes of measurement, he gives the following results of his own observations:—In the Germanic peoples the average internal capacity varies between 1400 and 1550 c.cm. In Celts, Romans, and Greeks we find 1400 to 1500; in the Slavs the width of variation is about the same as in the Germans (but less exactly determined). Quite out of the series are the peoples of Hindostan; the narrow range of 1260 to 1370 includes all the members of this group. Individual examples of the Semitic and Hamitic peoples (of which the author had but few to examine) differ widely; but the Jews and Arabians here take a good position—1450 to 1470 c.cm. The Mongolians range from about 1320 (but mostly 1400) to 1500; 1350 to 1450 seems the proper range of the capacity of the Malays, and only very isolated stocks exceed these limits on both sides. The Papuans and Australians show the averages 1370 and 1320 respectively. The negroes vary between 1300 and 1400. A much lower figure appears for the Bushmen (1244). The Americans, finally, have a wide range; while they are normally between 1300 and 1400, they reach in some of their artificially deformed members a mean value of 1200 and even less. Sexual dimorphism (female skull smaller and flatter) is most pronounced in all civilised peoples.

FROM a study of 650 thunderstorms that occurred in Italy in 1881, Signor Ferrari concludes that every thunderstorm is connected with a barometric, hygrometric, and thermic depression; it is behind the two former, and in front of the last. All three depressions, but especially the two latter, are associated with maxima, which are situated behind the barometric and hygrometric depressions, but before the thermic one. Most of those storms arose in the wide plain of the Po. Coming from west-north-west with a velocity of 30–37½ km. per hour, they passed (in case of their greatest range) with slackening speed over the Apennines in Upper and Middle Italy. For a given moment the thunderstorm has the form of a long narrow band, advancing, with numerous bends outwards and inwards, parallel to itself, and having its various characteristic phenomena most intense along the middle line. The *isohyetes*, or curves of equal rainfall, often take the form of ellipses, whose longer axes coincide with the direction of the storm. The dominant wind-direction is generally parallel to that of propagation of the storm.

THE Penny Science Lectures at the Royal Victoria Hall are about to recommence after the Christmas interval. Lectures hove been promised as follows:—Tuesday, February 2, Mr. W. P. Bloxam, "Fire, Fuel, and Illumination"; February 9, Mr. J. M. Thomson, "Dirty Water and how to Cleanse it"; February 16, Prof. George Forbes, "Shooting-Stars and Comets"; February 23, Mr. Wm. Lant Carpenter; March 2, Mr. T. Cunningham Porter, "English Cathedrals"; March 9, Dr. J. A. Fleming, "Niagara."

DR. ALFRED DANIELL'S "Text-book of the Principles of Physics" has been adopted, in Polish translation, by the University of Cracow.

A FOURTH edition of Prof. Tyndall's "Six Lectures on Light, delivered in the United States in 1872–73," has been issued by Messrs. Longmans and Co.

THE Council of the City and Guilds of London Institute have received an application from the Board of Technical Education of New South Wales requesting them to forward examination papers in technology to the colony, and award certificates and prizes on the results. This application has been referred to the special committee of the Institute on technological examinations.

AT the forthcoming Indian and Colonial Exhibition the Canadian Government intend to demonstrate the manner in which fish culture is prosecuted in the Dominion, and the various methods adopted in regard thereto will be practically illustrated to the public, and shown together with live specimens of Salmonidæ indigenous to native waters. Canada now possesses about twenty hatcheries, most of which have been constructed since 1873, and worked with the greatest success, whitefish being the chief source of reproduction. Preparations are already being made for the reception of the Canadian exhibits, which will be very numerous, and replete with interest.

LARGE consignments of whitefish and trout ova have arrived at the South Kensington Aquarium from America as a presentation from the Commissioners of that country. In consequence of the success attending the introduction of the first-named fish into this country last year, special attention is to be given to their culture during the present season with a view to their distribution in some of our chief lakes. The National Fish Culture Association have extended their hatchery, and, in order to secure healthy embryos, have adopted the new method, viz. the "underflow" system, which has been found to incubate the ova at a less rate of mortality than the "overflow" system.

DR. SAMUEL TENNY, the indefatigable investigator of Roman antiquities on and around the Lake of Constance, has now at last succeeded in laying bare the forum of the old Roman city of Brigantium (Bregentz), the so-called "Rhätische Pompeii." It consists of an area on the "Oelrain" inclosed by a wall furnished with roofed halls. There are also the remains of a building with stairs and eight columns, evidently a portico of imposing proportions, besides two gates leading to streets. The remains are unfortunately in a very dilapidated condition, and their total destruction is imminent.

IN the eleven years from 1873 to 1884 the number of lions killed in Algeria was 202, for which a premium of 400*l.* has been paid by the Government. The number of panthers destroyed in the same period is 1214, and the money paid by the Government 720*l.* About 400*l.* has been paid for 1882 hyænas, and 1600*l.* for 27,000 jackals. The large felidæ are almost extirpated principally in the western provinces, and the lion of the desert is fast becoming a myth.

IN the *Transactions* of the Verein für Erdkunde at Halle a writer describes certain cave-dwellings in the province of Saxony. These are occasionally found in loess formations in the Balkan Peninsula (in the Lom Palanka region, for instance), but it is somewhat startling to find them used now in such a cultivated place as Saxony. They are in the neighbourhood of Halberstadt, quite close to the village of Langenstein. Here in a sandstone hill, about a dozen caves have been dug, which are used as dwellings. They have different rooms, light and dark, as well as chimneys, windows, and doors, and are said to be very dry and habitable. The writer of the account, a physician, says that he found the inhabitants quite comfortable, and that some of them had lived there for more than thirty years without suffering from any evil effects to their health.

WE have on our table the following new books:—"Zoological Record," vol. xxi. 1884 ("Zoological Record" Association); "The Definitions of Euclid," by R. Webb (Geo. Bell and Sons); "Organic Chemistry," by H. F. Morley (Churchill); "Elementary Algebra," by Chas. Smith (Macmillan and Co.); "Eminent Naturalists," by Thos. Greenwood (Simpkin and Co.).

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; two White-billed Parrakeets (*Tanygnathus albirostris*) from Celebes, a Bearded Lizard (*Amphibolurus barbatus*) from Australia, purchased; a Common Otter (*Lutra vulgaris*), British, received in exchange.

OUR ASTRONOMICAL COLUMN

THE DENSITY OF SATURN'S RING.—M. Poincaré supplies a short note on the stability of Saturn's ring in the November number of the *Bulletin Astronomique.* Laplace had shown that the ring could only be stable if it were divided into several concentric rings revolving at different speeds. M. Tisserand had confirmed this result, and had recognised that a single ring must, in order to exist, possess a much higher density than the planet, and had calculated the maximum breadth of each elementary ring in terms of its density and mean radius. M. Poincaré has carried this investigation a step further, and shown that if the density of a ring be less than a certain amount, it will, under the influence of the slightest perturbation, no longer break up into a number of narrower rings, but into a great number of satellites, and that if the rings be fluid and turn each as a single piece, the density of the inner ring must be at least 1/5, and of the outer ring 1/16 that of the planet. For a ring of very small satellites (not for a fluid-ring, as M. Poincaré erroneously states), Maxwell has shown the condition to be that the density should not *exceed* 1/300 part of that of Saturn.

We do not at present know the actual density of the ring from observation sufficiently accurately to make therefrom any certain inference as to its physical condition. Bessel's determination from the movement of the peri-saturnium of the orbit of Titan gave the reciprocal of the mass of the ring as compared with that of Saturn as 118, which, since the volume of the ring—adopting Bond's value of 40 miles for its thickness—is about 1/400 that of the planet, would make its density about 3·4 times greater than the planet's. Bessel's value is, however, clearly too great, as he neglected the influence of the equatorial protuberance of Saturn on the movement of the apsides. Meyer's determination of the secular variation of the line of apsides of Titan, viz. $d\pi = 1726''·5$, gives the reciprocal of the mass of the ring as 26700, but from all the six brighter satellites as 1960; the latter value closely agreeing with Tisserand's. It does not, however, seem to have been noticed that even the smallest value for the mass considerably exceeds the highest permissible in accordance with Maxwell's result, since that would make the mass of the rings only 1/120,000 part of the planet's, an amount we cannot hope to detect with our present resources.

THE ORBIT OF TETHYS.—Herr Karl Bohlin has recently communicated to the Swedish Academy of Sciences an interesting discussion of the elements of the orbit of Tethys. The observations discussed are those of Sir Wm. Herschel, 1789, reduced by Lamont, Lamont, 1836, Sir J. Herschel, 1835–7, the Bonds, 1848–52, Secchi, 1856, Capt. Jacob, 1857–8, Newcomb and Holden, 1874–5, and Meyer, 1880-1. The elements are calculated for each period of observation, without taking account of perturbations. Herr Bohlin, then specially treating the mean longitude of the epoch, and adopting 190°·69812 as the value of the mean motion, draws up tables of the differences between observation and calculation, and attempts to represent them by an empirical formula. The corrected value of the mean motion is 190°·698169, almost identical with that found previously by M. Baillaud. Herr Bohlin finds that the annual motion of the peri-saturnium amounts to 33°. M. Baillaud's results and M. Tisserand's investigations had given the value as 70°. The excentricity is found as $0·00803 \pm 0·00077$.

THE ORBIT OF IAPETUS.—Prof. Asaph Hall has published a memoir containing a very full discussion of all the observations of Iapetus made at Washington from the mounting of the 26-inch refractor until February 29, 1884. His finally-adopted elements are deduced from his own observations made between June 10, 1875, and the above-mentioned date. And in deducing them he has taken account of the perturbations produced by the sun, Iapetus being so distant from its primary that, notwithstanding the distance of Saturn from the sun, these perturbations cannot be neglected. The periodic time of the satellite was found, from a comparison of Herschel's observations in 1789 with the conjunctions observed in 1880 and 1881, to be 79·3310152 mean solar days. The adopted mean distance determined by two different methods of observing—one by differences of R.A. and declination, and the other by angles of position and distances, which give very accordant results, is $515''·5195 \pm 0''·02645$. The corresponding reciprocal of the mass of Saturn (including the planet, its ring, and its satellites) is $3481·3 \pm 0·54$, closely agreeing with that found by Meyer from his observations of the six brightest satellites, viz. $3482·93 \pm 5·50$.

A NEW METHOD OF DETERMINING THE AMOUNT OF ASTRONOMICAL REFRACTION.—M. Lœwy proposes to determine refraction by placing a glass prism with silvered faces, forming a double mirror, in front of the object-glass of an equatorial. By means of this arrangement the images of two stars—one at the zenith, and the other near the horizon—can be simultaneously viewed in the field and their distance measured. This distance will be affected by the maximum amount of refraction.

If after an interval of three or four hours, when the stars have equal zenith distances (and therefore are relatively but little displaced by refraction), the observation be repeated, the comparison of the two measures gives the means of determining the amount of refraction with great accuracy. For the success of the method it is, of course, essential that the measured distance should be absolutely independent of every possible displacement of the various parts of the apparatus in the interval between the observations. This result is attained, M. Lœwy considers, by placing the double mirror in such a position that the planes of reflection for the two stars coincide, as he finds that under these circumstances, whatever small displacements the prism may undergo, the distance in the field of the telescope measured in the plane of reflection or the projection of this distance on the trace of the plane of reflection in the field remains invariable.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JANUARY 31—FEBRUARY 6

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on January 31

Sun rises, 7h. 42m.; souths, 12h. 13m. 42·5s.; sets, 16h. 46m.; decl. on meridian, 17° 19′ S.: Sidereal Time at Sunset, 1h. 29m.

Moon (New on February 4) rises, 4h. 54m.; souths, 9h. 21m.; sets, 13h. 47m.; decl. on meridian, 18° 25′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 8	11 8	15 8	22 23 S.
Venus	8 2	13 48	19 34	3 30 S.
Mars	20 36*	3 7	9 38	5 23 N.
Jupiter	21 44*	3 43	9 42	0 59 S.
Saturn	13 15	21 26	5 37*	22 40 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Phenomena of Jupiter's Satellites

Jan.	h. m		Feb.	h. m.	
31	1 21	I. occ. reap.	5	1 7	II. ecl. disap.
31	22 30	I. tr. egr.	5	5 32	I. ecl. disap.
Feb.			5	5 47	II. occ. reap.
2	22 19	III. ecl. disap.	6	3 36	I. tr. ing.
3	1 14	III. ecl. reap.	6	5 51	I. tr. egr.
3	2 19	III. occ. disap.	6	21 53	II. tr. ing.
3	5 1	III. occ. reap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Feb.	h.	
6	9	Venus at least distance from the Sun.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m
U Cephei	0 52·2	81 16 N.	Feb.	1, 23 0 *m*
			,,	6, 22 39 *m*
Algol	3 0·8	40 31 N.	,,	3, 4 4 *m*
			,,	6, 0 53 *m*
λ Tauri	3 54·4	12 10 N.	,,	3, 2 6 *m*
ζ Geminorum	6 57·4	20 44 N.	,,	2, 9 30 *M*
U Monocerotis	7 25·4	9 32 S.	,,	3, *M*
δ Libræ	14 54·9	8 4 S.	,,	5, 0 20 *m*
U Coronæ	15 13·6	32 4 N.	,,	6, 5 23 *m*
U Ophiuchi	17 10·8	1 20 N.	,,	1, 0 51 *m*
		and at intervals of		20 8
R Scuti	18 41·4	5 50 S.	Feb.	5, *m*
β Lyræ	18 45·9	33 14 N.	,,	1, 17 0 *m*
δ Cephei	22 24·9	57 50 N.	,,	4, 2 30 *M*

M signifies maximum; *m* minimum.

Meteors

The *Virginids*, R.A. 175°, Decl. 14° N., form the principal February shower. Fireballs may be looked for on February 2.

GEOGRAPHICAL NOTES

The *Izvestia* (1885, v.) contain another letter from M. Potanin, describing his interesting journey to the Upper Hoang-ho. Leaving Si-nin (Tsin-ning) on May 2, the Expedition visited the Humbum Monastery—a trading-place for Russian goods brought from Urga and transported further to Thibet—and crossed a high ridge of mountains, the pass having an altitude of no less than 12,000 feet above the sea. Following the valley of the Lan-chou (Dun-ho-tsian on Prjevalsky's map), they ascended to the plateau of Rchandza-tan, about 10,000 feet above the sea, leaving to the north the snow-clad mountains of Naryn-jamba, where Prjevalsky spent the winter of 1880. Only Tanguts inhabit this elevated table-land, and a few lamas who occupy several monasteries. Descending from the plateau into a deep valley, Naryn-jamba, which joins that of the Urung-vu River, they were soon compelled to climb another plateau of the same height, the Ganja-tan, also peopled by Tanguts. The Amni-Tunglyng Mountains raise their snow-covered summits towards the north. On May 16 the Expedition reached the Labran Monastery, situated at an altitude of 10,000 feet, and still containing several hundred well-built houses, some of them with two and three stories. The Gue-guen—a religious chief, who is also chief of the neighbouring Tanguts—resides at this rich monastery. From Labran, MM. Potanin and Skassi again climbed a high plateau, and followed it until they arrived at the Renu-kika Pass. A high snow-covered ridge extending west and east on the left bank of the Tao-ho, was seen to the north; it is inhabited by a tribe of Tangut robbers—the Tebu. The Tao-ho flows along a valley more than half a mile wide, between picturesque craggy mountains, the slopes of which are thickly wooded. The town Ming-cheu, situated in the same valley, could thus soon be reached. Leaving it on June 16, the Expedition easily reached also the Yali-san Mountain, which is the watershed between the tributaries of the Tao-ho and the Yang-tse-kiang, the ascent to the watershed offering no difficulties. The further journey to Si-gu-sian was made in an alpine country, intersected by deep and narrow valleys, which have a flora offering some notable differences from that of the Si-nin and Min-cheu region. The town Si-gu-sian is situated in the region of the monsoons. The further intentions of the Expedition were to go to Niang-pin, leaving M. Berezowski at Si-gu-sian to make collections of mammals and birds.

An extraordinary meeting of the Geographical Society of Paris was held on the 21st inst. to receive M. de Brazza on his return from his latest expedition to that part of Western Africa which is now described as the French Congo. M. de Brazza gave an account of his journey undertaken in the summer of 1883, on a subsidy from the Government of 1,250,000 francs (50,000*l*.). In the beginning of June he and his party had reached Franceville on the Ogowai. At this place he concluded new treaties with the chiefs of the tracts adjoining the river, and opened warehouses for carrying on trade. After instructing in their duties the Europeans who were to remain at Franceville, M. de Brazza crossed the elevated tract which separates the basins of Ogowai and Alima to join Dr. Ballay, who was conducting negotiations with the Bapfourous, a tribe settled near the junction of the Alima with the Congo. Dr. Ballay had a steamer on the latter river, the first French vessel of the kind which had penetrated so far into these regions. M. de Brazza then narrated his adventures in the two years and nine months during which he was engaged in exploring the banks of the Ogowai, the Alima, and the Congo, in laying the foundation of eight stations.

The *Calcutta Englishman* states that Mr. Needham, of the Assam Police, and Capt. Molesworth, of the Bengal Staff Corps, who left Sadiya on December 12 for Rima, in Thibet, have returned to Dibrugarh. They reached Rima, but were unable to enter the place, owing to the hostility of the Thibetans. Having followed the course of the Brahmaputra the whole way from Sadiya to Rima, they are able to state authoritatively that the river corresponding in size to the "Sanpo," as described by the explorer "A. K.," falls into it; and that the identity of the "Sanpo" with the Dijong may be deemed to be finally settled.

The Government of the Congo State has commissioned several geographers to execute maps of the entire State. Lieut. Massari is surveying the right bank of the Congo between the Alima and Mobangi Rivers. The topographical party under Lieut. Junghers has surveyed Banana completely, and is now engaged, in two divisions, in surveying the districts between Banana and Boma, and between Boma and Vivi. The Swedish geographer Herr Hakanson has drawn a map of the district between the village of Mvinda, above Vivi, and the Issanghali Station.

Advices received in Berlin contradict the statement of the death of the German traveller, Dr. Büttner, who is now alleged to have escaped all the dangers that beset him in the Congo region, and to be on his way back to Europe.

WITH the beginning of next month a party organised by the German New Guinea Association will start from Hamburg. The command of the expedition has been intrusted to Dr. Schraber, one of the staff of the Hamburg Observatory, who was chief of the scientific expedition sent in 1882 to the southern hemisphere. The preparations are almost completed. Six experienced foresters have been already sent on in advance. Fifteen block-houses have been constructed, some at Hamburg, some in Norway, to be put together at chosen points in New Guinea. Forty Malays have been hired in Java to act as bearers and servants, and five persons trained in various branches of natural science will form the staff of the party. Their explorations will be confined to the portion of the island which is under the German protectorate, and will, it is expected, occupy about three years.

THE Milan Society for the commercial exploration of Africa is preparing a new expedition to Zeila and the neighbouring districts. It will be led by Count Peter Porro.

THE census returns of the provinces of Bosnia and Herzegovina for 1885 show an increase of 15 per cent. in the population since the previous returns for 1879, the respective figures being 1,158,440 and 1,336,101. Nearly all the inhabitants are of South Slavonic (Servo-Croatian) stock and speech, and, according to religions, they were distributed in 1885 as follows:—Mussulmans, 492,710; Orthodox Greeks, 571,250; Roman Catholics (Greek and Latin rites), 265,788; Jews, 5805; Miscellaneous, 548.

THE Viennese firm of Hartleben has begun the publication of Dr. F. Umlauft's important work on the Alps, entitled "Manual of Alpine Sciences." It will be issued in fifteen parts.

FATHER LEO M. ALISHAN, of the Armenian Mekhitarist Congregation of St. Lazarus near Venice, has recently published a sumptuous work entitled "Sissûan," the term applied by the Armenians to the province of Kilikia at the end of the twelfth century, when it was governed by Leo the Magnificent. The work deals with the physical geography, history, and literature of this region of Asia Minor, and contains numerous maps, fac-similes, and illustrations, besides several valuable unedited documents.

THE *Bollettino* of the Italian Geographical Society for December has a short obituary notice of the distinguished geographer and geologist, Prof. Giuseppe Ponzi, who was born in Rome in 1805, and died there on November 30, 1885. He filled the Chair of Geology in the Roman University since the year 1866, and on his careful surveys of the basin of the Tiber were based the first geological maps of that district.

THE same *Bollettino* contains some particulars of the Capucci-Cicognani Expedition, which arrived at the capital of the Anfari (Sultan) of Aussa at the end of August. Here it was detained by the Anfari, who demanded 3000 dollars for the right of passage, and after tedious negotiations Capucci returned to Assab in order to procure this sum, and thus obtain permission to pass on to the kingdom of Shoa in Southern Abyssinia. On his return he induced the Anfari to accept less than half the amount claimed, on payment of which the Expedition continued its journey through Gafra for Shoa.

To the *Bollettino* Count A. Salimbeni sends a description, with illustration, of the bridge he has now completed over the Temcha, a river in Gojam, which flows through the Birr to the Abai (Bahr-el-Azrag, or Blue Nile). The bridge, the first constructed in Abyssinia since the time of the Portuguese, spans the river with three arches of 8·50 metres each, is 4 metres wide, and has a total length of 38 metres. The work, which was begun in December 1884 and finished the following March, is looked on as a marvel by the natives, and has given great satisfaction to King John.

THE BENEFITS WHICH SOCIETY DERIVES FROM UNIVERSITIES[1]

NEXT, I mention as the subject for university study, Psychology, the nature of man's soul, the characteristics of his mental and moral activity. This science has lately made great progress, —it has improved its methods and enlarged its scope. Those who are devoted to it appreciate the inherited experiences of the human race and are not indifferent to the lessons which may proceed from intuition and introspection; they study all the manifestations of intellectual and spiritual life; but, on the other hand, they are not afraid to inquire, and they know how to inquire, into the physical conditions under which the mind works; they watch the spontaneous, unconventional actions of children; they investigate the laws of heredity; they examine with curious gaze the eccentricities of genius, and with discerning, often with remedial eye, the alienation of human powers, and they believe that by a combination of these and other methods of research, among which experiment has its legitimate place, the conduct of the human understanding and the laws of progressive morality will be better understood, so that more wholesome methods of education will be employed in schools of every grade. They acknowledge the superiority of the soul to the body, and they stand in awe before the mysteries which are as impenetrable to modern investigators as they were to Leibnitz and Spinoza, to Abelard and Aquinas, to Aristotle and Plato, the mysteries of man's conscious responsibility, his intimations of immortality, his relations to the Infinite.

I do not know whether philosophy is on a "return to Kant," or to common sense, but I believe that standing firm on the postulates, God, Soul, and Immortality, it will in years to come disentangle many perplexities, brush away heaps of verbal accumulations, and lead the mind to purer and nobler conceptions of righteousness and duty. I go even farther, and, as I believe that one truth is never in conflict with another truth, so I believe that the ethics of the New Testament will be accepted by the scientific as well as the religious faculities of man; to the former, as Law; to the latter, as Gospel.

In confirmation of these views, let me quote to you the language of that one among us who is best qualified to speak upon this subject.

"The new psychology, which brings simply a new method and a new standpoint to philosophy, is, I believe, Christian to its root and centre; and its final mission in the world is not merely to trace petty harmonies and small adjustments between science and religion, but to flood and transfuse the new and vaster conceptions of the universe and of man's place in it—now slowly taking form and giving to reason a new cosmos and involving momentous and far-reaching practical and social consequences—with the old scriptural sense of unity, rationality, and love beneath and above all, with all its wide consequences. The Bible is being slowly re-revealed as man's great text-book in psychology, dealing with him as a whole, his body, mind, and will, in all the larger relations to nature and society, which has been so misappreciated simply because it is so deeply divine. That something may be done here to aid this development," continues the lecturer, "is my strongest hope and belief."

The study of Society engages the earnest interest of another set of men, and the apparatus of their laboratory includes archæological and historical memorials of the activity of the race. The domain of history and political science has never been cultivated as it is in modern times. The discovery of primæval monuments and the interpretation of long hidden inscriptions, the publication of ancient documents once hidden in monasteries and governmental archives, the inquiry into primitive forms of social organisation, the development of improved modes of research, the scientific collection and classification of facts which illustrate the condition of ancient and modern communities and especially the interest awakened in the growth of institutions and constitutions, give to this oldest of studies the freshest interest. Papers which have lately been printed on rudimentary society among boys, on the laws of the mining camp, on the foundations of a socialist community, on the differences between parliamentary and congressional government, on the derivation of modern customs from the ancient beginnings of the Aryan people, on the nature of communism and many more such themes, afford illustrations of the mode in which the historical student among us, following the lines of Stubbs, Maine, Freeman, Seeley, Bluntschli, Roscher, and other celebrated workers, are advancing historical science, and developing the true historical spirit. The aim of all these inquiries is to help on the progress of modern society by showing how the fetters which now bind us were forged, by what patient filing they must be severed, and at the same time to work out the ideal of a society in which Liberty is everywhere, but "Liberty sustained by Law."

Languages and Literature have always received attention in universities, and will always be dominant for reasons which are

[1] An Address by D. C. Gilman, President of the Johns Hopkins University. Continued from p. 283.

as enduring as language itself. We study tongues that we may know the men of other climes and other days; we study literature to enjoy it. As an aid to intercourse with people of other nations and for the purpose of keeping up with the record of modern science, nobody doubts that the modern languages are to be encouraged; but if we really would own the inheritance which is our birthright, if we wish to appreciate the masterpieces of literature, if it is well to put ourselves in sympathy with mankind, to laugh with those who have laughed, and weep with those who have wept, we must not be restricted to the writings of to-day. In science, it has been said, read the newest and latest; not so in literature—but the best. Isaiah and John, Homer and Æschylus, Cicero and Virgil, the "Nibelungen Lied" and Chaucer, Dante and Petrarch, are as full of life, beauty, instruction, and entertainment to us as to former generations. But from the classical standard of excellence this busy world would soon depart, were it not that in every university there are scholars keeping bright the altar fires, and warming us with the glow of their enthusiasm, whenever we come under their influence—sharpening too our wits by their critical acumen.

It is not uncommon, nowadays, to hear objections to classical education, usually from those who have never had it, and declamations against dead languages, usually from those who have never learned them. But the Humanists may unquestionably leave it to the Geologists to fight the battle for antiquity. The latter assure us that the older the fossils the more instructive their lessons; indeed, so much importance is attached to ancient animal life that the national government, with great liberality, encourages its study by promoting explorations, museums, and costly publications. Be it so; but let not the nation which does this forget that men are of "more value than many sparrows"; that the oldest literature is not old or dead, but fresh and living in comparison with the bones of the cave-dwellers; and that though a Megatherium is wonderfully instructive, an ancient epic or a drama is not unworthy of attention.

Jebb, in his life of Bentley, asserts that probably "the study of classical antiquity, in the largest sense, has never been more really vigorous than it is at the present day." We might add that classical poetry has never been so popular—else why these innumerable editions and translations? Why, after Worsley, Butcher, Bryant, and their predecessors, are we reading aloud and smiling over the immortal Odyssey as it is given to us in the rhythmical prose of Palmer? This is a good sign; only it is well to remember that reading translations is not reading Greek, and, as Jebb goes on to say, we must not forget the difference between "the knowledge at second hand," which the intelligent public can possess, and "the knowledge at first hand" which it is the business of the libraries and professorships of a university to perpetuate.

If the defenders of classical study would confine their argument to the line which was lately followed by Butcher, they would silence their opponents. "To Greece," he says, "we owe the love of science, the love of art, the love of freedom—not science alone, art alone, or freedom alone, but these vitally correlated with one another and brought into organic union. . . . The Greek genius is the European genius in its first and brightest bloom. From a vivifying contact with the Greek spirit, Europe derived that new and mighty impulse which we call progress."

But I must not pass from the subject without a word upon the study of language in general, that faculty of the human race which was never half understood until the universities of Germany entered upon the study of comparative philology, by the introduction of Sanscrit study. With this new torch they have thrown a flood of light upon the nature of speech, the history of our race, the brotherhood of nations, and the development of ideas which lie at the basis of all Indo-European civilisation.

The Shemitic tongues have long been subjects of university study, especially Hebrew and Arabic—the former so much esteemed as the language of the Old Testament that it used to be spoken of as the language of Paradise, and the latter being regarded as a key to the ideas and religion, the ancient literature and science, of one of the largest families of men. Of late years the domain of Shemitic study has been widened; libraries long hidden have been exhumed on the sites of ancient Babylon and Nineveh; records, the very existence of which was unknown at the beginning of this century, written in characters to which there was then but the slightest clue, are now read and printed and studied as a part of the history of mankind. Assyrian becomes a language of university study—not, indeed, for many scholars, but for a few, and the bearing of their discoveries is so important upon the language and history of the Hebrews that one of the most learned of English theologians has recently said that, in respect to certain of the obscurer passages of the Old Testament, the world must wait for the light which would come from Assyriology.

Certainly, if the history of mankind is worth studying, if the lessons of the past are of value, language and literature, the ancient, the modern, the primitive, and the cultivated, will never be neglected among the studies of an enlightened community.

When we turn from Man to his environment, we soon perceive that mathematics lies at the basis of all our knowledge of this world. To count, to measure, and to weigh, are steps in civilisation, and as we extend our powers in these directions, we find that even the distance and mass of the planets, the form of the earth, the velocity of light, the mechanical equivalent of heat, and the unit of electrical resistance may be accurately ascertained, and the results, with many of the ideas which they involve, may become a part of the intellectual possessions of every educated person. Yet when we reflect that hardly any branch of knowledge is so depreciated by the average man as the modern advancement of pure mathematics, we must believe that its influence upon civilisation is not sufficiently considered.

Prof. Cayley, in a recent address, alluded to the connection of mathematics with common life, on the one hand, and with the deepest questions of philosophy, for example, the metaphysical ideas of time and space, on the other. As to its utility, he declared that he would defend this science as Socrates defended justice, quite irrespective of worldly advantages,—and then he proceeds to show the relations of mathematics to the certainty of knowledge, and to emphasise the idea that mathematical science is not built upon experience but upon certain fundamental assumptions—which are indeed found to be in conformity with experience. I wish that every student, however remote his studies may be from mathematical text-books, would turn to the opening passages of this discourse, and steady his own mental equilibrium by the assurance that the science which is most exact, and most satisfactory in its reasonings, is based upon fundamental postulates which are assumed and not proved by experiment. "In the theory of numbers," he says, "there are very remarkable instances of propositions observed to hold good for very long series of numbers—and which are nevertheless untrue."

If you persist in taking the utilitarian view, and ask me what is the good of Mr. Glaisher's determination of the least factors of the missing three out of the first nine million numbers, the volume containing the sixth million having lately been published;—or if you put a much more comprehensive question, what is the use of the Abelian functions, I shall be forced to say, I do not know; and if you press me harder I shall be obliged to express my conviction that nobody knows; but I know, and you know, and everybody may know, who will take the pains to inquire, that the progress of mathematics underlies and sustains all progress in exact knowledge.

Whewell, the author of the "History of Inductive Sciences," has brought out very clearly the fact that "the opening of Greek civilisation was marked by the production of geometry, the idea of space was brought to a scientific precision; and likewise the opening of modern European civilisation was distinguished by the production of a new science, Mechanics, which soon led to the mechanics of the heavens, and this step, like the former, depended on men arriving at a properly distinct fundamental idea, the idea of force." Henry Smith, arguing for the value of his favourite study to mankind, points out the injury which would come to the intellectual strength of any nation "whose notions of the world and of the things in it, were not braced and girt together with a strong frame-work of mathematical reasoning. It is something," he continues, "for men to learn what proof is and what it is not." The work in mathematics at Alexandria or Syracuse two thousand years ago is as perfect in its kind and as direct and unerring in its appeal to our intelligence, as if it had been done yesterday at Berlin or Göttingen by one of our own contemporaries. In kindred language, Cayley, working forward as well as backward, and not unmindful, let us hope, of the Sylvestrian school upon this side of the Atlantic, in which he had been a master and a guest, thus concluded the address from which I have already quoted:—

"Mathematics has steadily advanced from the time of the Greek geometers. Nothing is lost or wasted; the achievements of Euclid, Archimedes, and Apollonius are as admirable now as they were in their own days. Descartes' method of co-ordinates is a possession for ever. But mathematics has never been cultivated more zealously and diligently, or with greater success than in this century—in the last half of it or at the present time; the advances made have been enormous, the actual field is boundless, the future full of hope. In regard to pure mathematics we may most confidently say,

"'Yet I doubt not thro' the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the suns.'"

Many who hesitate to assent to these views of the relation of pure mathematics to civilisation, have no hesitation whatever in lauding applied mathematics, especially astronomy and physics; and no wonder, for within the memory of this generation, the world has gained these five results of physical science, steam locomotion, telegraphy, telephony, photography, and electric lighting. The first three, it may be said, have revolutionised the methods of human intercourse; the fourth has multiplied infinitely the means of communicating knowledge to the brain by what Sir William Thomson, following John Bunyan, has termed the Eye-gate; and the fifth, still in its dawn, includes possibilities of illumination, which we are not likely to exaggerate. But I have no time to eulogise these recent gains of civilisation; every word I can spare must be given to emphasise the fact, which is most likely to be forgotten, that these wonderful inventions are the direct fruit of university studies. I do not undervalue the work of practical men when I say that the most brilliant inventor who ever lived has been dependent upon an unseen company of scholars, the discoverers and the formulators of laws which he has been able to apply to methods and instruments. Nor do I forget that Faraday, like Shakespeare, was not a university man. But I mean to say that the manifold applications of science, about which everybody is talking, are only possible because of the abstract studies which universities promote. The electro-magnetic inventions which are now so multiform are only possible because scores of the greatest intellects of the century, one after another, have applied their powers of absolute reasoning to the interpretation of phenomena which could have been elucidated in any part of the world, and at any epoch of the past, if only the right methods had been employed. As long as universities held aloof from experimental sciences, these discoveries were not made, but when laboratories for investigation were established, an alliance was formed by mathematics and physics, and a new type of intellectual workers was produced, men whose hands were as cunning to construct and make use of instruments, as their brains were cunning to develop the formulas of mathematics. Take the splendid list of leaders who have followed Franklin and Rumford. They may be called the school of Sir Isaac Newton, so much of their inspiration is due to him. Not all were trained in academic walls; but not one failed to derive help from the advantages which universities provide and perpetuate.

One of the greatest of these men, Sir William Thomson, has lately been here. He was invited to come because it was believed that he, more than any other foreigner, could give an impulse to the study of physics in this country. His lectures were on a subject so remote from ordinary thought that I do not suppose its announcement conveys to those who are unfamiliar with the present position of physical inquiries, the least idea of what the lecturer was to talk about. Nevertheless, so great was the attraction of his powers, that a large company, two or three from England, one from Japan, several from beyond the Alleghanies, and many from this neighbourhood, most of them teachers and professors of physics, here assembled daily for a month to catch what they could of his learning and his enthusiasm. His words were taken down and have been given to the public in the form of lecture notes, and have thus reached already the principal seats of learning abroad and at home, but the chief results of his visit will be seen as the years go on in the increased devotion of his followers to their science, and in their emulation of his enthusiasm and concentration. Could I give you a more interesting example of the way in which a university may encourage physical science?

Notwithstanding all the progress in physics and astronomy which has been made during a century, those who know the most about these subjects will assure us that they are but at the alphabet of their science. Read the address of the Astronomer of Princeton, on a recent occasion, in which he enumerates the impending problems of astronomy; or that of one of our own staff, when he reviews the condition of electrical science, and declares that "as the region of the unknown is infinitely greater than the known—there is no fear of there not being work for the whole world for centuries to come;" and he adds (to please, I suppose, the practical men) that in the applications of science, "the telephone, the telegraph, and electric lighting, are but as child's play to what the world will see."

Chemistry is the child of the nineteenth century. The atomic theory, which lies at the foundation of all modern investigations, was announced by Dalton,—(that English Friend after whom it would not be amiss to name our chemical laboratory "Dalton Hall," as a tribute alike to his eminence and to the society in which our founder was also trained),—Dalton's law, I say, was announced between 1804 and 1808, so that we can trace more distinctly than in most sciences the exact influences under which chemistry has grown up. Alchemy, the search for gold or for the philosopher's stone, never became a science, and contributed very little to the good of man; but when the universities of Europe, with their trained observers, their methods of accurate work, their habit of publication, and especially their traditional principles of co-operative study, directed their attention to the fundamental laws of atomic combination, the science of chemistry grew with rapidity, and with benefits to mankind which can never be enumerated. To no man were its early days more indebted than to Liebig—"of organic chemistry the very source and fountain-head"—good as a thinker, good as an investigator, good as a lecturer, but better still, as one of his most illustrious pupils has informed us, "in the peripatetic teaching of his laboratory."

"It was at the small University of Giessen," says Hofmann, from whom I have just quoted, that "Liebig organised the first educational laboratory that was ever founded. This school forms an epoch in chemical science. It was here that experimental instruction such as now prevails in our laboratories received its earliest form and fashion, and if we are proud of the magnificent temples raised to experimental science in all our schools and universities, let it never be forgotten that they all owe their origin to the prototype set up by Liebig, half a century ago." The world appreciates the results which have proceeded from these laboratories—let it also be remembered that they were the creation not of industrial fabrics, not of mercantile corporations, not even of private enterprise, but of universities, and that the motive which inspired their founders and directors was not the acquisition of wealth, but the ascertainment of fundamental law.

The science which began with the century is going forward more rapidly than ever. Yet, if we examine a recent exposition of the principles of theoretical chemistry, we may discover that here, as in mathematics and in physics, the most expert perceive that the field which is open to investigation is much vaster than that which has been surveyed. Here, as everywhere else, the higher one ascends the greater his horizon. What good is to come to men from these researches it would not be wise to predict; but we may reflect on what has recently occurred. Within the last few months a boon has been conferred on humanity so great that all the cost of all the laboratories of all the lands in Christendom would have been a small price to pay for so precious a pearl. It came into the world never again to leave it, unheralded, unexpected, from the laboratory of science, to deaden for a few moments and then restore to life the organs of the sight, so that operations on the eye, hitherto dreaded, may be performed without the slightest pain. The chemists may modestly say that this discovery was an accident not to be compared in significance with the discovery of Avogadro's law. That may be so, yet this sort of accident does not happen in Africa or the Fiji Islands,—it "happens" where there are universities and laboratories, and trained men able and ready to observe, discover, and apply.

The hour has passed, and I have hardly introduced a theme which would be more appropriate for a volume than for a discourse. I have not spoken of the study of the structure of the earth, the physics of the globe, the laws of storms, the constituent rocks and minerals of the earth, the record of life hidden in ancient strata, the living kingdoms of animals and plants, the distribution of the races of men, the progress of archæology—or of innumerable subdivisions in the great branches of human knowledge. Such a task would be beyond my powers; I have only attempted to suggest what each one of you may study for the rest of your lives, as you watch the growth of universities and the progress of knowledge. I have purposely left for another occasion all questions pertaining to professional and technical education.

A few miles east of one of my former homes—the settlement of Berkeley, in California—there is an isolated peak of moderate height, from the top of which you may survey an area equal to that of the State of New York. From Mount Shasta on the north to Mount Whitney on the south, you may trace the jagged, often snow-white, crest which bears the name of Sierra Nevada. Here and there a peak rises a little higher than its neighbours, and can be identified from the look-out; but human vision cannot see the chains beyond the chains, nor the marvellous valley Yosemite and the beautiful Lake Tahoe which are sheltered within the nearest range of hills. All that the eye can distinguish on the horizon are a few of the loftiest summits as it turns toward the east, and a glimpse of the Farallone Islands as it turns toward the west. So to-day, from a hill not very high, we have looked upon a broad area, distinguishing only the chief features of the landscape,—but we have seen the mountains and the sea.

A NEW ISLAND IN THE SOUTH SEAS

According to the *Melbourne Argus* of December 10, further news respecting the volcanic outbreak which recently occurred in the Friendly Group has been received from Fiji, *viâ* Auckland. Intelligence concerning it first arrived there by the schooner *Midge*, from Tonga. Before the vessel arrived, however, the eruption had already reported itself to the eastern portion of the Fiji Group, and the *Argus* Correspondent furnishes the following account of it:—

"At Ogea, one of the island outposts lying nearest to the point of eruption, and distant from it about 175 miles in a south-west direction, heavy discharges as of siege artillery were heard on October 14, and continued at short intervals up till the 17th. It is to be noted in connection with this that the outbreak occurred, or was first noticed, in Tonga on the 12th, and that mention is made of 'a low rumbling noise at intervals during the night.' During the continuance of these heavy discharges, Ogea was frequently and very violently shaken by earthquakes, so that the people were in a state of great consternation. At night-time a lurid glare, as from a great fire, was visible in the direction of Tonga, and these phenomena culminated in a terrific roar on the morning of the 17th, such as might be produced by thousands of big guns being discharged simultaneously. Next day a small vessel which had been working the open sea between the Fijian and Friendly Groups, called in to Ogea and reported having passed through vast fields of pumice. This served to confirm the idea generally prevailing that a terrible calamity in the form of a volcanic outbreak had befallen and had overwhelmed Tonga."

The Tonga Correspondent of the *Fiji Times*, who was an eye-witness of the eruption, has communicated the following account of it to that journal:—

"On the night of Sunday, October 11, 1885, more than one slight shock of an earthquake was felt, and lightning was seen at intervals at different quarters. Several persons noticed a low rumbling noise at intervals during the night. At sunrise on Monday morning, October 12, the natives reported that a steamer was coming in. The Tongan Government was induced to send out the schooner *Sandfly*, and about noon on the day the outbreak was first seen Dr. Buckland, accompanied by the Premier and various officials, started to see the volcanic eruption which it was evident was going on. The *Sandfly* returned on the 16th inst. and reported having reached the scene of the eruption on the 13th, but too late to see much: that on the following morning a small island became for the first time visible, and that the vessel had approached within about a mile of the shore, but a strong current prevented nearer approach. On October 17 a number of residents chartered Tugi's schooner, and started for the spot, and on the succeeding morning witnessed a spectacle of such surpassing magnificence as men have seldom been permitted to view. An island of, I believe, not less than nine miles superficial area was seen by us, which had been upheaved, presuming the *Sandfly's* observations to be correct, within four days. On its shore a submarine volcano was belching out a fearful quantity of what I believe to be steam and salt water, throwing it upwards in a column for a distance, I was told by a competent gentleman, of a mile. To give an accurate description in detail of the column and eruption generally is impossible. It is indescribable. The shapes assumed by the steam clouds, after the greatest height had been reached, were inexpressibly beautiful, and were fantastic to a degree. While these clouds were still wreathing and curling, another and another column, with well-defined lines, would shoot upwards, and the downpour of liquid and the wreathing and curling were again and again renewed. The island, named by many 'Fakaogo fei lagi,' or Takaogo Island, is situated about 16 or 20 miles to the north-west of Honga Hapai. I have not a chart to refer to, but believe it is on the site of the Culdibras (?) Reef, marked on the chart, and which is some distance south of Tonga and Kao. Vessels coming here from Fiji will be able to visit the island without going much from their course. At night time flashes of light are seen, but whether proceeding from flames of volcanic fire or from the electricity generated during the condensation of the volumes of steam, will be best known to scientific people. Many and various are the conjectures as to how the island has been formed, and conjectures alone can be made until the island is visited. The whole matter is likely to create great interest, and will afford an opportunity to scientific people to ascertain, with a tolerable amount of certainty, the exact manner in which these islands of the Pacific have in past ages been produced. The height of the island on the occasion of the visit of the *Sandfly* was from 20 to 30 feet, and when we saw it on Saturday it appeared to be from 200 to 300 feet."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Oxford.—Whatever be the fate of the new Moderations Scheme now being considered by a Committee of Congregation, the present academic year will be remarkable for the vigorous onslaught made by the younger Faculties on the time-honoured requirement at Pass Moderations of "a little Latin and less Greek." The waste of a year over classical work having no direct bearing on the final school chosen by the student had become so great a tax on time and patience that, when a blow was at last struck at the evil, but little opposition was expressed in quarters where small sympathy with modern studies was thought to dwell. If the Committee can agree on a working scheme, a great relief will be afforded to students in Natural Science in Oxford.

It is with much pleasure that we notice, after long interval, two Colleges offering Fellowships in Pure Science. Merton offers a Fellowship in Physics, and Lincoln in Biology. Besides these Fellowships, Pembroke has a vacant Medical Fellowship.

The nomination of Examiners in the Honour School of Natural Science (now conducted by a Committee of the Faculty) took place this week. Prof. Burdon-Sanderson succeeds Dr. Gamgee in Physiology, Mr. H. B. Dixon succeeds Mr. Vernon Harcourt in Chemistry, and Mr. J. Walker succeeds Mr. Hayes in Physics.

The following courses of lectures and practical classes will be held during the present term:—

In the Physical Department of the Museum, Prof. Clifton lectures on Electricity, Mr. Walker on Polarised Light, and practical instruction is given by the Professor, Mr. Walker, and Mr. Selby. At Christchurch Mr. Baynes lectures on Thermodynamics, and gives practical instruction in Electrical Measurements. At Balliol Mr. Dixon lectures on Elementary Heat and Light.

In the Chemical Department of the Museum Prof. Odling lectures on the Phenic Compounds; Mr. Fisher continues his course on Inorganic Chemistry, and Dr. Watts continues his course on Organic Chemistry. Practical instruction is given by Messrs. Fisher, Watts, Marsh, and Baker. Practical instruction is also given in the Christchurch and Balliol Laboratories.

In the Morphological Department Prof. Moseley lectures on the Anatomy of the Vertebrata; Mr. Spenser has a course on Elementary Animal Morphology; and Mr. Barclay Thompson, on the Osteology and Distribution of the Amphibia and Reptilia. Mr. Arthur Thomson lectures on Human Myology, and has a class for Practical Anatomy. Practical instruction in Comparative Anatomy is given by the Professor, and Messrs. Robertson and Spenser.

In the Physiological Department Prof. Burdon-Sanderson lectures on the Physiology of the Nervous System, and will also give twelve elementary lectures during the present and next term on the Vital Phenomena of men and animals. Mr. Dixey lectures and has a class for Practical Histology; Dr. Gotch has a class for Practical Physiology; and Mr. Poulton lectures on the Physiology and Histology of the Special Senses.

In the Geological Department Prof. Prestwich lectures on the Palæozoic series; Prof. Story-Maskelyne on Crystallographic Symmetry; and Dr. Tylor on Mankind, their Distribution, Antiquity, and Early Condition.

At the Botanical Garden, Prof. Bayley Balfour lectures and gives practical instruction in Vegetable Morphology and Physiology. Prof. Gilbert lectures on Field Experiments.

Scholarships in Natural Science are offered this term by Magdalen and Jesus Colleges, and next term by Queen's College.

The next examination for a Radcliffe Travelling Fellowship will commence on Monday, February 8.

CAMBRIDGE.—Mr. J. H. Randell, M.A., who has been elected to a Fellowship at Pembroke College, was 5th Wrangler in 1882, first class in the Natural Sciences Tripos, Part II., 1883, and is now additional Demonstrator of Experimental Physics.

It is proposed by the Council that the appointments of University Lecturers shall be tenable "for such a term of years, not exceeding five, as the General Board shall prescribe," the statutable provision for cancellation remaining still in force for extraordinary occasion.

A Shuttleworth Scholarship at Gonville and Caius College is vacant, and an examination for it will commence on March 19 next. The subjects are Botany and Comparative Anatomy in its most general sense (including Zootomy and Comparative Physiology), and there will be practical work in all these subjects. Candidates must be registered medical students of Cambridge University, and at least of eight terms' standing. The Scholarship is of the value of 60*l*. per annum, and tenable for three years. A Foundation Scholarship may be awarded to the successful candidate in addition.

In the scheme of Entrance Scholarship Examinations at Girton College recently issued no Natural Science subject is included in the optional subjects. One Gilchrist Scholarship, tenable at Newnham or Girton, will be awarded, among other groups, for proficiency in Physical and Natural Science at the next Cambridge Higher Local Examination.

OWENS COLLEGE, MANCHESTER.—The following appointments have recently been made:—To the Brackenbury Professorship of Physiology, William Stirling, M.D., D.Sc., Regius Professor of the Institutes of Medicine in the University of Aberdeen; to the Lectureship in Medical Jurisprudence, John Dixon Mann, M.D., M.R.C.P.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, No. 717, September 1885.—J. Sartain, on the ancient art of painting in encaustic.—Dr. P. H. Van der Weyde, on the new system of telegraphy to and from moving trains. This paper describes Phelps's method of communicating by induction.—A. E. Outerbridge, a lecture on matter.—S. W. Holman, friction of leather belts on iron pulleys; an experimental study of the slip, and coefficients of sliding friction.—A. S. Greene, on the jacketing of working cylinders of steam-engines.—Otto Luthy, on Florida sugar.—Pedro G. Salom, on the metallurgy of steel; an essay on Bessemer and other modern processes.

No. 718, October 1885.—E. A. Gieseler, on tidal theory and tidal prediction.—Chief-Engineer Isherwood, an account of experiments on a condensing compound engine.—C. L. Gateley and A. P. Kletzsch, cylinder condensation in steam-engines. Gives first part of some researches made on a large engine by two students of Stevens Institute.—W. Curtis Taylor, three new portraits of Washington. A study in composite photography.—F. Lynwood Garrison, the microscopic structure of iron and steel. Accompanying this paper are several photo-lithographed plates, one of which shows the transition in structure of a "burned-out" fire-grate bar of cast-iron into steel by the action of the fire.

No. 719, November 1885.—E. A. Gieseler, on tidal theory and tidal prediction (conclusion).—C. L. Gateley and A. P. Kletzsch, cylinder condensation (continued).—Pedro G. Salom, recent improvements in the manufacture of iron and steel. Describes the "Clapp-Griffiths," the "Davy," the "Gordon," and the "Avesta" processes.—Prof. E. J. Houston, glimpses of the International Electrical Exhibition, No. 8. Reis's articulating telephone. An exhaustive examination of Reis's various suggestions and instruments.—S. H. Needles, a translation of a note of M. Blavier on the influence of electric storms on subterranean telegraph wires.

Wiedemann's Annalen, Band xxvi. No. 10, October 1885.—Fr. Kohlrausch, on the conductivity of certain electrolytes in extremely dilute aqueous solutions. This paper contains an historical summary of methods and results; a discussion of the method of working with alternate currents; accounts of various new experimental researches.—E. Pfeiffer, on the electric conductivity of mixtures of ethyl-alcohol and ethyl-ether. The author believes that both pure alcohol and pure ether possess metallic conductivity, though both are extremely bad conductors.—G. C. Foster, on a modified form of Wheatstone's Bridge and a method of measurement of small resistances. This is a reprint of Prof. Foster's paper of 1872 in the *Journal* of the Society of Telegraph Engineers, which appears to be unknown outside England.—A. Oberbeck, on a phenomenon of electric oscillations similar to resonance. This refers to the effect of condensers on alternate currents recently investigated by Hopkinson.—K. Angström, on the diffusion of radiant heat from plane surfaces. The research was made by an apparatus called a "galvanic differential thermometer," resembling Langley's "bolometer." Results are given for a number of substances at different angles of incidence.—A. Schleiermacher, on the dependence of heat-radiation upon temperature and the law of Stefan. These researches confirm the accuracy of Stefan's law for perfectly black bodies.—M. Thiesen, on the law of the resistance of air.—E. Dorn, experimental confirmation, for pyro-electricity, of the law that the two kinds of electricity are generated in equal quantity.—E. Dorn, some lecture experiments. These relate to Leslie's apparatus, interference of sounds, vortex-rings, Puluj's apparatus for Joule's equivalent, and cooling of wire by sudden extension.—P. Brühl, on forked lightning.

No. 11, November.—E. Gumlich, theory of Newton's Rings in transmitted light. The author concludes that the effect of multiple reflection in the air-film is to render the dark rings incompletely dark in the transmitted set, and the bright rings incompletely bright in the reflected set.—Leonhard Weber, measurement of intensity of diffused daylight. The quantities and qualities of daylight at Breslau were measured against those of standard flames from December 1884 to July 1885, with the following mean relative figures:—December, red 3834, green 11,514; January, red 6875, green 20,447; June, red 51,803, green 151,233; July, red 37,309, green 105,230.—W. von Bezold, on formation of the triangle of colours by true colour mixture. Three shaded triangles of red, blue, and green are optically superposed.—W. Müller-Erzbach, dissociation of salts containing water.—F. Kohlrausch, on the inconstancy of the damping-function of a galvanometer, and its influence on the determination of absolute resistance by means of the earth-inductor.—R. Colley, on some new methods for observing electric oscillations, and some applications of them. To measure electric oscillations the author has applied (1) a telephone receiver, (2) a mirror-oscillometer, and (3) a gas-flame oscillometer; descriptions of these are given, with drawings.—A. Koepsel, determination of the constants of electro-magnetic rotation of the plane of polarisation of sodium light in bisulphide of carbon. The apparatus was a modified Lippich's half-shadow polarimeter. The result gave for the absolute unit of rotation at 18° C., $0{\cdot}0419913' \pm 0{\cdot}0000078'$; in close agreement with Lord Rayleigh's value, $0{\cdot}042002'$.

Journal de Physique, t. iv., September 1885.—H. Dufet, experimental researches on the variation of the indices of refraction under the influence of temperature. The points comprised are: (1) variation of ordinary and extraordinary indices of quartz; (2) variation of index of water by prism method and by method of Talbot's fringes with aid of a lamina of quartz; (3) variation of indices of fluor and of beryl by the same method; (4) variations of indices of bisulphide of carbon, of monobromnaphthaline, turpentine, and alcohol by means of a lamina of quartz immersed in these liquids. The extraordinary index of quartz varies about seven times as much as the ordinary index, with variations of temperature.—MM. Bouty and Foussereau, on the employment of alternating currents for measuring liquid resistances. They criticise Kohlrausch's methods, in which a bridge and a receiving telephone are used, and show that ordinary resistance coils cannot be relied upon as having no self-induction. They describe a liquid rheostat, without polarisation, capable of giving resistances from 24 to 62,000 ohms.—M. Bourbouze, new models of hygrometers. In these instruments, which are modifications of the dew-point hygrometer, the formation of the first film of dew is observed by causing the deposit to be made on thin glasses which form the sides of the ether-chamber, when, on viewing a candle or other luminous point through the glass, coloured halos are visible.

SOCIETIES AND ACADEMIES

London

Royal Society, December 10, 1885.—"On the Relation of the Reptiliferous Sandstone of Elgin to the Upper Old Red Sandstone." By Prof. John W. Judd, F.R.S., Sec.G.S.

The question of the geological age of the yellow sandstones of the district lying to the north of the city of Elgin has been, as is well known, the subject of very animated discussions among geologists. Some have even gone so far as to assert that the evidence on the question, which has been adduced by stratigraphists, is absolutely incapable of reconciliation with that relied upon by palæontologists.

After detailing the successive discoveries of fossils in these beds from 1844 to 1877, in which latter year Prof. Huxley published his well-known monograph on *Stagonolepis*, the author proceeds:—

In the year 1884 I saw in the Elgin Museum the cast of a skeleton which had recently been obtained from the new quarry near Elgin, to be more particularly referred to in the sequel. This fossil appeared to me to be so different from all the remains hitherto found in the formation, that I obtained an impression of it and submitted it to Prof. Huxley, who recognised in it certain characters distinctive of the Dinosauria. From the same quarry a skeleton apparently belonging to another lizard, distinct both from *Telerpeton* and *Hyperodapedon*, with portions of the skeleton of the last-named genus, were also obtained.

Returning to Elgin in the autumn of the present year, I was told by my friend Dr. Gordon that another reptilian specimen, including the skull and some other parts of the skeleton, had been found in the same quarry. On examining this specimen I at once saw that it exhibited the characteristic features of *Dicynodon*, and my opinion on the subject was confirmed by my friend Dr. Traquair, F.R.S., of Edinburgh, who, at my request, proceeded to examine the specimen. A second example of the same genus has since been discovered, and I trust that ere long a full account of this interesting form will be given by Dr. Traquair.

In addition to these facts, I may add that casts of teeth, undistinguishable from those of *Ceratodus*, were some time ago obtained from the Spynie quarries.

The present state of the palæontological evidence concerning the age of the beds then is as follows. The strata have yielded the remains of no less than *four* orders of reptiles, all of them belonging to forms very different from any which have been found in Palæozoic rocks. The Lacertilia are represented by *Telerpeton*, *Hyperodapedon*, and an undescribed form; Crocodilia by *Stagonolepis*; Dinosauria by an undescribed skeleton, and possibly by *Dasygnathus*; and Dicynodontia by two individuals of the type genus. In addition to these we have a great number of footprints differing so greatly in form or size that they must probably have been made by creatures of very different proportions and organisation.

It will be seen from this summary that the palæontological evidence in favour of the Triassic age of the Elgin sandstones is now absolutely overwhelming. Besides the remains of *Hyperodapedon* and *Dicynodon*, genera which appear to be confined to Triassic strata, in districts so widely separated as South Africa, India, the Ural Mountains, and the British Islands, we have *Stagonolepis*, a crocodile with Mesozoic affinities, the highly organised lizard *Telerpeton*, and Dinosaurs; the last-mentioned having never been found in any rocks older than Trias. *Ceratodus*, too, has usually been regarded as having commenced in the Trias, though it must be admitted that difficulty may exist in separating the cast found at Spynie from *Ctenodus*, which occurs in the Carboniferous, or *Dipterus*, which occurs in the Devonian.

Let us now inquire what is the nature of the stratigraphical evidence which has been regarded as opposed to the palæontological arguments in favour of the Triassic age of this formation. At the outset it is necessary to bear in mind two very important circumstances. First. The exposures of the Reptiliferous Sandstone and of the Upper Old Red in the district are more or less isolated, the greater part of the country being thickly covered by drift and other superficial deposits. Secondly. The whole of the rocks in the district exhibit evidence of having undergone great disturbance; this is shown by their steep inclinations, and by the foldings and fractures which can often be recognised in the quarries opened in them.

The Reptiliferous Sandstone makes its appearance at the surface in two parallel ridges, ranging from north-east to south-west for a distance of about nine miles. The most northerly of these ridges extends from Brandenburgh to Burghead. Although the rocks are well exhibited both in sea-cliffs and in reefs on the shore, the only fossils obtained from them are the footprints of the Cummingston and Hopeman quarries, near the south-western extremity of the ridge, and the remains of *Stagonolepis*, *Telerpeton*, and *Hyperodapedon*, found in a single bed at Lossiemouth, at its north-eastern end. A tract of about three miles wide, thickly covered by superficial deposits, completely isolates the northern or coast ridge from the southern one, which is known as the Quarrywood ridge. In this Quarrywood ridge the Reptiliferous Sandstone is only found along its northern face for a distance of about three miles. The southern slope is composed of the ordinary rocks of the Upper Old Red Sandstone, containing *Holoptychius nobilissimus*, Ag., with species of *Glyptopomus* and *Pterichthys*. There is no evidence of the occurrence of Triassic strata, either along the southern slopes of the Quarrywood ridge or in the district lying still further south about the city of Elgin. The localities in which the sandstone containing reptiles has been found along the northern slope of the Quarrywood ridge are as follows:—At Spynie, which may be regarded as a north-eastern prolongation of the Quarrywood ridge, the deep quarries have yielded *Telerpeton*, *Hyperodapedon*, and *Ceratodus*. At Findrassie Wood, a mile and a half further to the south-west, a quarry, now abandoned, has yielded *Stagonolepis* and *Dasygnathus*. Lastly, the quarry near the top of the ridge, above New Spynie Church, and a mile and a half still further to the south-west than Findrassie, has yielded *Hyperodapedon* and another lizard with a Dinosaur and a Dicynodont.

In both the coast ridge and the Quarrywood ridge, as was well pointed out by Dr. Gordon, the Reptiliferous Sandstone is seen to be covered by a very peculiar and easily-recognisable deposit, known as the "Cherty rock of Stotfield." It has been frequently suggested that the preservation of these two sandstone ridges, and thus of the whole peninsula between Burghead Bay and Spey Bay, was in all probability due to the presence of this remarkable rock, which offers such resistance to the ordinary agents of denudation.[1] The rock consists of a more or less intimate admixture of siliceous and calcareous materials, including also crystallised patches of galena, blende, and pyrites; it has yielded no trace of organic remains. Sir Roderick Murchison compared the "Cherty rock of Stotfield" with the Cornstones of the Old Red series, with which, however, they have but little in common; and some confusion appears to have arisen from bands of true Cornstone, which occur in Upper Old Red Sandstone to the south of Elgin, with the Cherty rock of the Trias.

Prof. Harkness in 1864 was able to show that the positions in which the Cherty rock and the Reptiliferous Sandstone occur in the neighbourhood of Elgin are such as can only be explained by the existence of great faults. At a later date I showed how numerous are the indications of disturbance in the district—evidence of tilting of the beds, of actual contortion, and of fracture occurring in many of the quarries. On the north of the coast-ridge I have shown that beds of Inferior Oolite are found faulted against the Trias at Stotfield,[2] and probably also at Burghead. In the great "Scars," or reefs, which lie off this coast red sandstones are seen, and I have been assured that scales of *Holoptychius* occur in them. The presence of these great lines of dislocation is unquestionable, and in the paper referred to I have endeavoured by means of dotted lines to indicate the approximate position of some of them. It must be remembered, however, that in a country so deeply covered by drift as Northern Morayshire, the working out of the relations of the rock-masses by tracing their outcrops at the surface is an almost hopeless task.

As throwing an entirely new light on the age and relations of

[1] *Quart. Journ. Geol. Soc.* vol. xx. (1864), p. 424.
[2] *Ibid.* vol. xxix. (1873), p. 128, &c.

the Reptiliferous Sandstone of Elgin, I was able to show in the year 1873 that strata identical in character with that deposit and with the Cherty rock of Stotfield occur on the northern as well as on the southern side of the Moray Firth. At Dunrobin, in Sutherland, the yellow sandstones are seen covered by the Cherty rock, and this in turn is overlain in apparently conformable sequence by the various members of the Lias and Oolite. The whole of the Mesozoic strata of Sutherland are seen to be thrown by a great fault against the Lower Old Red and the crystalline rocks of the Highlands.

Although it is certain, however, that some of the cases of juxtaposition between the Old Red and the Triassic strata must be due to faulting, yet there were reasons for believing that the latter strata lie directly and unconformably upon the former. But, as was remarked by Dr. Gordon in 1877, "the district is so covered by drift that no junction of the Holoptychian and the Reptiliferous strata has been laid bare."

It was therefore with the greatest interest that in the summer of 1884 I learned from that veteran geologist, whose important services to science have extended over a period of more than half a century, that the bones of reptiles had at last been detected in the same quarry with the remains of *Holoptychius*. On repairing to Elgin, I found evidence that a somewhat coarse variety of the Reptiliferous Sandstone is seen passing downwards into a bed of conglomerate from three to four feet thick, which is known to the workmen as the "pebbly-post."

It was also found that the "pebbly-post," which in its lower portion becomes more perfectly conglomeratic, and contains pebbles of white and purple quartz up to the size of the fist, rests on beds of pink and red sandstones, very finely laminated, and exhibiting evidence of much false-bedding. These beds are strikingly different in character from the coarse-grained white sandstones lying above the "pebbly-post," in which the bedding is usually indistinct and imperfect. The stone lying below the conglomerate was found to be unsuited for building purposes, and the trial shaft, after being carried to the depth of thirteen feet in the bottom-rock, was abandoned; very fortunately, however, the last blast which was fired in it revealed a remarkably fine specimen of *Holoptychius*, which has been identified by Dr. Traquair as *H. nobilissimus*, Ag., and is now in the Elgin Museum.

These facts all point to the conclusion that the Reptiliferous Sandstone of Elgin passes downwards into a bed of conglomerate, which rests unconformably upon the strata of the Upper Old Red.

The Royal Society long ago testified its sense of the importance of determining the age and relations of the remarkable strata of Elgin, by appointing a Committee and making a grant from the Donation Fund to aid in securing new specimens of the fossils. Seeing, then, that an opportunity offered itself for determining the exact relations of the Reptiliferous to the Holoptychian beds, I preferred a request to the Council of this Society for a grant to be applied in excavations directed to uncovering the line of junction between the two beds.

My request having been granted, I had the great advantage of the aid and judicious counsel of Prof. T. G. Bonney, F.R.S., President of the Geological Society, in examining the section laid bare, and he permits me to state that he fully concurs in the following statement.

We were able to observe that, while the conglomerate of the "pebbly-post" graduates insensibly into the overlying Reptiliferous Sandstone, it is sharply divided from the red sandstones below. It was unfortunately found that, owing to the imperfect bedding of the upper series and the prevalence of oblique lamination in the lower one, it was impossible to obtain decisive evidence of a discordance of dip between them. But the line of junction between the two sets of strata showed every appearance of being an eroded one. We came to the conclusion that while the upper series having the "pebbly-post" for its base, is certainly perfectly distinct from the lower one, there can scarcely be the smallest doubt that the former rests unconformably upon the latter; in other words, the evidence points to the conclusion that during the vast periods of the Carboniferous and Permian, the Upper Old Red Sandstone of the Elgin area was upheaved and denuded, and the Upper-Trias beds were deposited unconformably upon their eroded surface.

The paper concludes with a *résumé* of all that is known of this formation, which has proved of such interest both to geologists and to biologists, and a comparison with the strata of the same age in other parts of Scotland and in Scandinavia.

Zoological Society, Jan. 19.—Prof. W. H. Flower, V.P.R.S., President, in the chair.—A letter was read from Dr. C. S. Minot (25, Mount Vernon Street, Boston, U.S.A.), calling attention to the Elizabeth Thompson Science Fund for the advancement and prosecution of scientific research, and inviting applications for assistance from it.—A communication was read from the Rev. T. R. R. Stebbing, containing descriptions of some new Amphipodous Crustaceans from Singapore and New Zealand.—Mr. Howard Saunders exhibited an adult specimen of the Sooty Tern (*Sterna fuliginosa*), caught alive near Bath, October 1885, and pointed out that only two examples of this species had as yet occurred in Great Britain.—Mr. H. J. Elwes read a paper on the butterflies of the genus *Parnassius*, having special relation to the development, functions, and structure of the horny pouch found in the females of this genus. He described the habits, distribution, and variations of twenty-three species which he recognised in the genus; and illustrated his remarks by the exhibition of a very complete collection of specimens and drawings. The paper was supplemented by Prof. Howes's remarks on his examination of the anatomy of the *Parnassius apollo*, and by Mr. Thomson's notes on the habits of the insects as bred in the Society's Gardens in 1885.—Mr. Oldfield Thomas, F.Z.S., read a paper containing a list of the specimens of mammals collected in various parts of India and presented to the British Museum by Mr. A. O. Hume, C.B. The series consisted of about 400 specimens, nearly all in excellent condition and with accurate localities attached to them. A new mouse from Tenasserim was proposed to be called *Mus humii*. A new Flying Squirrel from the Malay Peninsula was named *Sciuropterus davisoni*.—A communication was read from the Rev. Canon Tristram, containing the description of an apparently new species of duck (*Dafila*) from Sidney Island of the Phœnix group in the Central Pacific, which he proposed to name, from its extreme simplicity of plumage, *Dafila modesta*.—A communication was read from Mr. A. G. Butler, containing a description of the larva, pupa, and imago of a butterfly (*Aporia hippia*) from specimens bred in the Society's Gardens.

PARIS

Academy of Sciences, January 18.—M. Jurien de la Gravière, President, in the chair.—Memoir on M. de Saint-Venant and his scientific work, by M. Ed. Phillips.—On a new mercurial bath intended to deaden the vibrations of the ground, by M. Mouchez. This contrivance, at once simple and practical, has been invented by M. Gautier for the purpose of diminishing the vibrations of the ground at the Paris Observatory, caused by passing traffic. A cylindrical cast-metal basin containing the supply of quicksilver, has attached to the centre a wormed axis, to which is riveted a second and somewhat smaller basin furnished with a corresponding female-screw. The latter is pierced with a small aperture, through which the layer of quicksilver enters. This layer then becomes insensible to the vibrations, provided the screw be neither too tight nor too loose. The appliance has already yielded excellent results, for the first time enabling regular observations of the nadir to be taken at the Paris Observatory.—Remarks on MM. Paul and Prosper Henry's astronomical photographs, presented to the Academy by M. Mouchez. Since the proofs obtained of the Milky Way last June, MM. Henry have continued their labours with a success that has surpassed all hopes. The results already secured have been pronounced by competent judges the very perfection of astronomical photography, full of promise for the future of astronomy. Perfectly distinct images of several thousand stars down to the sixteenth and even the seventeenth magnitude have been obtained, as well as the nebula near Maia in the Pleiades and other objects absolutely invisible to the most powerful telescopes. Amongst other photographs presented are forty-two proofs of the Milky Way and various regions of the heavens; the neighbourhood of ϵ Lyræ showing some stars far smaller than the *debilissima* of Herschel, and below the sixteenth magnitude; the neighbourhood of Vega, with stars even feebler still than the foregoing, some of which have certainly never before been seen; the groups of Hercules, Sobieski, Ophiuchus, and Perseus, and over 600 images of double or multiple stars; a very successful photograph of the nebula of Orion and of several of the planets.—Note on the irreducible pure reciprocants of the fourth order, by Prof. Sylvester.—Note on an electric spectrum peculiar to the rare earths of the terbic group, by M. Lecoq de Boisbaudran.—Collection of plans or designs of ancient and modern vessels, with the elements necessary for their construction; third instalment, presented to the Academy by Admiral Paris.—Considerations relative to the illumination of lighthouses by means of electricity, by M. Félix Lucas. It is shown that the voltaic arc presents two decided advantages over mineral oil: greater brilliancy and less expense. The only drawback is the somewhat capricious instability of its light, a defect so inherent in the nature of the voltaic arc, that at present it seems impossible completely to remove it.—Note on the solar statistics of the year 1885, by M. Rod. Wolf. The tabulated results of solar observations made at the Zurich Observatory, and of magnetic observations made at Milan, shows that the relative number and magnetic variation have both considerably diminished at about the same rate since the year 1884.—On hitherto unrecognised wave-lengths, by M. Langley. From his protracted researches the author concludes with some reserve that the radiations, whose lower limit was determined by Newton at 0·0007 mm., have now been extended to 0·0150 mm., that is to say, to over twenty times Newton's limit. Thus the great gap that existed between the lowest known vibration of light and the highest of sounds, has been partly filled up.—On the velocity of the flow of liquids, by M. Th. Vautier.—On the secondary or persistent luminous impressions, second note, by M. F. P. Le Roux. The author concludes for the present that the seat of the phenomenon, to which these persistent images are due, lies about the back part of the eyeball, and that probably one or more fluids play an important part in its production.—Action of the sulphur of antimony on the sulphur of potassium, by M. A. Ditte.—Note on a new synthesis of an inactive borneol, $C_{20}H_{16}(H_2O_2)$, by MM. G. Bouchardat and J. Lafont.—Action of high pressure on the animal tissues, by M. P. Regnard.—Influence of the anæsthesia produced by the inhalation of the protoxide of pure nitrogen on various functions of the animal system, by M. M. Laffont. This species of anæsthesia is not only more or less injurious in itself, but constantly causes functional disturbances, which may give rise to serious dangers, especially in certain physiological conditions.—Researches on the physiological and therapeutic action of acetophenone, by MM. Mairet and Combemale. From their experiments the authors conclude that acetophenone, which acts chiefly on the nervous system, is not a sedative, while its healing virtues appear to be very doubtful.—On the histogenesis of the elements contained in the ovaries of insects, by M. J. Perez.—A contribution to the study of the Eocene palms of West France, by M. Louis Crié.—Note on the Jurassic and Lower Cretaceous formations of the provinces of Grenada and Malaga, by MM. Marcel, Bertrand, and W. Kilian. These Andalusian formations appear to be of an essentially Alpine character, their composition resembling those of Sicily and South Tyrol. The upper layers also show strong analogies with the Balearic Islands, the Apennines and Alps of Lombardy.—Note on the photography of speech and its reproduction by oxhydric projection, by M. Léon Esquile. The author claims to have succeeded, by means of the photophone, in fixing on a photographic plate the modulations of the voice, afterwards reproducing the words by the telephone, projecting in oxyhydric light the positive image of the plate on Mercadier's selenium receiver.—The election was announced of M. Boussinesq as member of the Section for Mechanics, in place of the late M. Rolland.—The Academy was informed by the Mayor of Chamounix that the commune of Chamounix intended celebrating the centenary of the first ascent of Mont Blanc by de Saussure in the month of August 1887, when a monument erected to his memory will be unveiled. Subscriptions for the monument will be received by the Secretary of the Institute.

Berlin

Physical Society, November 20, 1885.—Dr. Gerstmann having given a report on the "Molecular Physics" of Herr Wittwer, Prof. Schwalbe delivered an address on wind-holes and ground-temperatures, a theme on which he has frequently before made communications to the Society. Notwithstanding that he had been engaged for years in the study of ice-cavities and wind-holes, the speaker had yet arrived at no conclusive judgment respecting the cause of them. Having been prevented in 1884 from instituting observations of his own, he had collected the literature of the subject, and had ascertained that ice-cavities and wind-holes were very widely diffused, but had not yet excited general interest to such a degree as to have become the subject of continuous observations. In the summer of 1885 Prof. Schwalbe made a searching investigation into the cold cavities and wind-holes in the neighbourhood of Questenberg, in the Southern Hartz. The gypsum here constituting the main mass of the soil showed very many cavities and wind-holes. The ice-cavity he had described on a former occasion, with its entrance by a smooth gypsum wall, was found by him this year entirely free of ice, and the temperature of the air in it was, on three different visits, always between 4° and 5° C. On the other side of the gypsum mountain he found a hole which, on former visits, was almost entirely filled with water, but was on this occasion quite dry, so that it could be examined to the interior extremity. Here, too, he found a low and uncommonly constant temperature of 5° in the proximity of the mouth, and of 4° at the far end. A large number of more or less small holes, whence cold air issued, was found on the same side of the mountain, which was almost bare, except for a few fruit-trees. Occasionally these holes were very close to the surface illumined by the sun, and yet their temperature, in all kinds of weather, was perfectly constant and low, mostly from 4° to 5°,—in one case 0°. Although, too, most of these cavities communicated by broader or narrower crevices with the interior of the gypsum mountain, yet nowhere in them could there be demonstrated any stronger current of air that might be claimed as the cause of a more powerful evaporation and cooling. Prof. Schwalbe, in conclusion, drew attention to two interesting phenomena he had observed in the gypsum strata of the Southern Hartz. These were the sinking of rivers, often accompanied by loud uproar, and the occurrence of intermittent lakes. The so-called "Bauerngraben" (peasants' ditch), near Rosslau, was, even in the last century, as the old contracts between the two neighbouring villages proved, sometimes a lake serving the one village for fishing purposes, and sometimes dry land, which was then tilled by the other village. Several channels at the bottom of the lake led to the interior of the gypsum rock, nevertheless the water, when it gathered here, stood for several years at a depth of from 10 to 15 metres, suddenly to disappear again. In the years 1876, 1877, and 1878 the "Bauerngraben" was filled with water, and since this last date it had been dry land. The meteorological conditions appeared to exercise no influence on this phenomenon. The cause of the sudden accumulation of water, and the just as sudden desiccation, was yet wholly unknown.

CONTENTS

THURSDAY, FEBRUARY 4, 1886

ASTRONOMY DURING THE NINETEENTH CENTURY

A Popular History of Astronomy during the Nineteenth Century. By Agnes M. Clerke. (Edinburgh: Adam and Charles Black, 1885.)

WE have read this book with very great interest and with no little pleasure. The authoress (for this learned volume is indeed the product of a lady's pen) has modestly described her "History of Astronomy" as a *popular* work. We certainly hope that the book will be as popular as it deserves, and that it will be widely and extensively read. We think, however, that few men of science who use this book will think that it ought to be classed as a popular work in the ordinary acceptation. It might be more correctly described as a masterly exposition of the results of modern astronomy in those departments now usually characterised as physical.

Prof. Grant's "History of Astronomy," now more than thirty years old, treated of astronomy prior to that remarkable development of the science consequent on the invention of the spectroscope; Miss Clerke may thus be said to have resumed the subject from the point which Prof. Grant reached, and her present work is well worthy of a place beside Grant's volume in every astronomical library.

In the opening pages of the introduction Miss Clerke distinguishes the three great branches of the science of astronomy. The primary branch is that known as "observational," which involves the art of observing the returns and measuring the places of the heavenly bodies, but is not concerned with schemes for harmonising these facts into a compendious theory. The second kind of astronomy is that founded by Newton, and is most appropriately termed "gravitational." It seeks to account for the main facts of astronomy, in so far as the movements of the bodies are concerned, by the operation of the law of gravitation. The third branch is that which Miss Clerke terms "physical and descriptive." This branch of astronomy embraces the detailed study of the features of the different celestial bodies, and also the examination of their actual character and chemical composition. The two first branches are the older and better-known parts of astronomy. It is in the third branch that the great developments of modern times have taken place. It is especially in this department that Miss Clerke's work will be found invaluable as giving a succinct and accurate summary of our knowledge.

The work is divided naturally into two portions. The first part describes the progress of astronomy during the first half of the nineteenth century. It opens with an account of the career of Sir W. Herschel and his discoveries. In subsequent chapters of the first part we have the account of the memorable achievements of Bessel and Struve in sidereal astronomy. We have also a useful sketch of the earlier observations on and theories with regard to the structure of the sun; the discovery of the minor planets; the development of the cometary discoveries so far as the laws of their motions are concerned; and an account of the instrumental advances up to the time of the great Rosse reflector.

It is, however, in the second part, on "The Recent Progress of Astronomy," that Miss Clerke has found a new field, which she has occupied with great success. The earlier chapters of the second part relate to the foundations of astronomical physics. There is an admirable account of the state of our knowledge with respect to sunspots, and of the results obtained from recent eclipses. The spectroscopic work on the sun is discussed in an able chapter, while the researches on the great constant of the universe—the sun's distance—fitly occupy another. Then we have an account of the recent discoveries with respect to the planets and their satellites, and of the theory of planetary evolution. Chapters X. and XI., on comets, are especially good, and the spectroscopic labours on stars and nebulæ are also well described. A chapter on the methods of research concludes a volume of 468 pages. The photographic and spectroscopic work is virtually the theme of this book, and any one who desires to learn what has been done by Huggins and Lockyer, or by Young, or Janssen, or Vogel, will find full and accurate information. An index is provided which might, however, have been a little more extended with advantage.

At nearly every point Miss Clerke is careful to quote the references to the original authorities: this is indeed so characteristic a feature in the work that it would be valuable for these references alone, though in saying this we do not imply the slightest disrespect to Miss Clerke's able epitome of the results of each paper she has quoted. Many years of labour must have been required for the production of this work, for Miss Clerke has evidently studied with elaborate care the original writings on each subject.

So far as we have seen Miss Clerke does not appear to have been herself an observer of the heavens, and once or twice remarks occur which would hardly have been made by one who is familiar with astronomy in its practical sense. We are told, for instance, on page 103, that Bessel when a boy, could see the components of ϵ Lyræ apart with the unaided eye; no doubt he could, but the remark would hardly have been made by one who knew that everybody with tolerable vision can do the same.

In some few places we think that it would have been better to have allowed vague old speculations to pass into oblivion than to furbish them up once again; what, for instance, is the advantage of reproducing Wright's doctrines about the Milky Way, or the astronomical theories of Kant? No astronomy is worth anything which is not grounded on accurate observation or rigid calculation. The "Central Sun" rubbish ought never to have again been printed. We have however but few criticisms to offer on a work so thorough and so carefully written. Miss Clerke has expressly disclaimed any intention of discussing the more abstract mathematical researches relating to astronomy; one of the few exceptions is to be found in a description of Prof. George Darwin's now celebrated theory of tidal evolution; the account here given is both interesting and accurate so far as it goes, but mathematicians do not like such expressions as "wasting its momentum as heat dissipated through space" (p. 316).

The literary style of Miss Clerke's work is especially admirable; a brief sentence is frequently found to contain an accurate and vigorous expression of an elaborate point. On page 3 we are told that "observation is the pitiless critic of theory." We are told that the probability of 61 Cygni forming a connected pair is actually greater than the chance of the sun rising to-morrow morning. We read of inconspicuous minor planets being difficult to detect "in the majestic disguise of a distant sun." We are told how Prof. Adams would not "take any steps to obtain a publicity which he was more anxious to merit than to secure." In referring to the same event, Miss Clerke describes how Lalande narrowly escaped the accidental discovery of Neptune, and adds: "An immortality which he would have been the last to despise hung in the balance; the feather-weight of his carelessness, however, kicked the beam." In speaking of the moon and the possible variations of lunar objects, Miss Clerke says: "A change always seems to the inquisitive intellect of man like a breach in the defences of Nature's secrets, through which it may hope to make its way to the citadel." There are charming bits of biography through the book: as of Olbers, who became a mathematician because he was an astronomer; of Encke, who became an astronomer because he was a mathematician; or of Schwabe, who, seeking his father's asses, found a kingdom.

There are, however, some few omissions, for which we hope in a future edition room will be made. We should have an account of Brünnow's work on stellar parallax. We think also that a history of modern researches on double-stars should include a notice of Dembowski's most elaborate observations; while the labours of Doberck deserve notice, as we owe to this indefatigable astronomer the greater part of our knowledge of the binary-star orbits. Miss Clerke has, however, fully appreciated the splendid work of S. W. Burnham, who has in ten years discovered 1000 double-stars. Those who are aware of the magnificent labours of Prof. Rowland, of Baltimore, on the solar spectrum will be disappointed in not finding some reference in a work of this kind. It must, however, be admitted that a complete account of Prof. Rowland's work has not yet been published.

Miss Clerke's most admirable work fills a widely-felt want. The progress of spectroscopy has been recently so rapid that it was often difficult to find out what was known and what was unknown. It is here that Miss Clerke renders an assistance that every astronomer must appreciate. He can in this volume obtain a vivid and accurate summary of what has been done, or, if he prefers to read the original memoirs, he will be directed where to find them. The work has been most skilfully and faithfully executed, and we heartily recommend it to every one who is interested in the noblest of the sciences.

ROBERT S. BALL

CRANIOGRAPHY

Eine exacte Methode der Craniographie. Von Dr. C. Rieger. (Jena: Verlag von G. Fischer, 1885.)

THIS work contains the description of a method of craniography employed by the author for upwards of five years for obtaining exact geometrical drawings from the skull or from the head of the living person. The first question dealt with by the author is the plane of orientation of the skull to be adopted. He discards all those which have for their aim the placing of the skull or head in the position natural to man, namely, with the axis of vision as nearly as possible horizontal, and prefers a plane determined by anatomical considerations alone. After studying different anatomical points on the skull for this purpose, he came to the conclusion that the most suitable is a plane running along the base of the cerebrum, extending in front from the angle which the horizontal and vertical portions of the frontal bone make internally with one another to the upper border of the sulcus transversus of the occipital bone, the attachment line of the tentorium cerebelli. This plane placed horizontally is the orientation of the skull adopted by the author. He then proceeds to consider the question of how far the proposed horizontal corresponds to the base of the cerebrum; and secondly, whether it can be determined on the periphery of the unopened skull or the head of the living. Sections of the skull show that the plane corresponds fairly in front with the base of the cerebrum, but posteriorly there is an elevation of the anterior part of the cerebellum and ganglia, so that it does not follow exactly the line of the cerebellum, though roughly it may be said to do so. The determination of the points on the exterior which correspond respectively to the anterior and posterior ends of the plane or long axis of the skull is of greater importance. The anterior point is defined as that point where a line joining the upper borders of the orbits crosses the median line of the skull. The posterior point is more difficult to define, as here several anatomical questions are involved, such as the relation of the protuberantia externa to the interna, and whether the latter corresponds to a fixed point externally. From his investigations the author found that the position of the attachment of the tentorium on which the posterior end of the cerebrum rests cannot be exactly determined in the unopened head or skull, but the variations in position of the external and internal protuberances in comparison to the whole cranial space are so small that the error is infinitesimal. Both in the skull and in the living the termination externally and posteriorly of the plane may be taken as that point where the linea semicircularis superior intersects the protuberantia occipitalis externa in the middle line, or in the living immediately above the line of attachment of the muscles. Having determined these points, he proceeds to show that the outlines of the dimensions of the skull in relation to this plane can be taken only with the assistance of ordinates standing at right angles to one another. He has satisfied himself that it is necessary to have complete outlines of the whole of the curves, and not only the greatest dimensions, so that a model of the skull from which they are taken can be at once apparent. Only a few of the most important curves require to be taken in every case: these are a curve of the ground or horizontal plane, of the median plane, and a third transversely over the cranium in the plane of the external auditory meatus.

The method of obtaining the curves is as follows:—Two threads are tied in the centre so as to form a cross; each end is weighted with lead. The knot is placed in the middle line on the crown of the head, so that it lies as nearly as possible on the shortest line between the nasion and the protuberantia occipitalis. It is of no consequence whether the knot of the thread lies a little forward or backward. Two arms of the thread are placed anteriorly and posteriorly, one over the nasion, the other over the occiput. The other two are placed transversely across the skull, so that they correspond to the anterior border of each auditory meatus.

The next thing is to fix the points at which the cross-threads cut the line of the ground-plane. For this purpose an elastic band is placed around the skull so that it lies on the anatomical points indicating the anterior and posterior ends of the long axis, and in a straight curve round the skull between these points. When the skull is placed with this line horizontal, we obtain the ground or horizontal plane from which the other curves are to be taken. For the purpose of recording the curves millimetre paper is used, and the principal axes of the skull marked off on it. The long or median axis is measured with calipers. The total length is divided by two, and each half is measured off in a straight line on the millimetre paper from a centre. By a similar process the transverse axis of the skull is obtained at the points where the transverse threads cut the horizontal plane. A rectangular figure is then drawn through each of these points, indicating the length and breadth of the cranium. This forms a boundary-line for the tracing. In order to determine at what point the transverse axis intersects the longitudinal axis in the skull, it is necessary to find out how far behind the midpoint of the long axis the transverse axis is situated. This is done by measuring the distance from the anterior point on the skull to the point where the transverse and horizontal planes intersect at the anterior border of each auditory meatus (which we shall call the "ear-point"), and then marking it off on the millimetre paper, taking as a starting-point the anterior end of the long axis. The true zero or middle point of the skull will be that at which the transverse axis intersects the long axis. This middle point may bear different relations to the middle point of the long axis in that it may coincide with it or be behind it. Whatever may be its relations to the long axis, the transverse axis must be placed on the paper, so that it crosses the centre of the rectangular figure. If the middle point is behind the centre of the long axis, the anterior end of that line will project a corresponding distance beyond the anterior boundary of the figure, while its posterior end will fall at a corresponding distance within it. This will show the projection of the skull forwards and backwards in relation to the anterior borders of the auditory meatus. Should the base of the skull or the ground plane not be symmetrical, the axis of length and that of breadth will not be at right angles to each other, but more or less oblique. Having fixed the position of the axes with respect to the rectangular figure, the horizontal curve is drawn on the paper in four segments in the following way:—A flexible, but absolutely inelastic piece of lead wire is laid on the skull, with its one end corresponding to the right ear-point; it is moulded to the skull, along the horizontal line, to the anterior point in front, then from the left ear-point to the anterior point, and finally from each ear-point to the posterior point. The segments are then carefully placed on the paper with the points all coinciding to those on the marked quadrilateral, and, with a pencil, a tracing on the paper is made along the inner side of the lead wire. In this way the outlines of several skulls can be superimposed; the transverse and longitudinal axes of all the skulls must, however, be made to coincide.

The median longitudinal curve is taken from the end points of the long axis in two pieces, as it is not possible to take it all at once, and the knot on the cross-threads is utilised for determining a point on the curve from which each segment can be taken. Its position is defined on the paper in the following manner:—With a pair of compasses the distance from the anterior end point to the knot is measured on the skull and then laid off on the paper backwards, starting at the anterior end of the long axis line. The distance from each side point to the knot is measured and laid off on the paper so that the two lines converge and meet in front. The distance of the point of union to the zero will represent the sagittal height of the skull. From the anterior end of the long axis a segment having a radius equal to the distance from the side point to the knot is marked off with the compasses on the paper, and another segment is likewise marked off from the zero point with a radius equal to the distance between the zero point and that at which the two side lines meet. Where the two segments intersect, we have a fixed point which will represent the position of the knot. The accuracy of the point so determined may be further verified by a similar process from the posterior end of the axis line. The lead wire is then laid along the curve, first the one half and then the other, and on being placed on paper is traced with a pencil.

Curves of the transverse diameters of the calvaria are taken in a similar manner.

The method is one which requires a considerable amount of care and time. It has the advantage of not requiring any complicated apparatus, but whether its results are equally reliable and compensate for the time required in the manipulation is possibly an open question. For laboratory work we are inclined to think that the stereograph of Broca will prove much more useful, and repay its cost in the rapidity and accuracy with which all the tracings described in Dr. Rieger's monograph can be made. Moreover, with the stereograph, drawings of the face can be made which are not practicable with the graphic method of Rieger.

The plane of orientation proposed by Rieger cannot be considered quite satisfactory, owing to the difficulty of determining accurately its posterior end. A plane of orientation of a purely anatomical character, which we have frequently used, is that with the basio-nasial line horizontal, it being the axis on which both the brain-case proper and the facial portion of the skull are developed. These anatomical planes have the disadvantage of placing the skull in an unnatural position, but are of the greatest use in comparing outlines of the side view of different skulls. For general purposes, however, we have found the alveolo-condylar plane of orientation to be the most useful.

J. G. Garson

OUR BOOK SHELF

Studies from the Laboratory of Physiological Chemistry of the Sheffield Scientific School of Yale College for 1884-85. Edited by Prof. R. H. Chittenden, Ph.D. (New Haven, 1885.)

THIS volume of some 200 pages is a reprint from volumes vi. and vii. of the *Transactions* of the Connecticut Academy, which were published between March and November of 1885. It contains eleven more or less important physiological memoirs, the result of work done in the Sheffield Scientific School of Yale College by Prof. Chittenden and his colleagues. The first memoir investigates the diastatic action of saliva as modified by various conditions, studied quantitatively, the joint author being Dr. Herbert Smith. The second is on the amylotic action of diastase of malt as modified by various conditions studied quantitatively, the joint author being Dr. Cummins. Diastase taken into the stomach must sooner or later be completely destroyed by either the free acid or the large percentage of acid proteids; but in the first stage of digestion, in the absence of free acids and under the protecting influence of proteid matter, the conversion of starch into sugar may still go on, though soon destined to feel the effects of the gradually increasing percentage of combined acid. The third memoir is by the Editor and Dr. Painter, on the influence of certain therapeutic and toxic agents on the amylotic action of saliva. The substances selected for study, besides those noted for therapeutic or toxic power, were also those possessed of antiseptic properties. Mercuric chloride, which acts so powerfully as a germicide, acts even more energetically on the organised ferment of saliva. It is interesting to find that air, oxygen, and carbonic acid all stimulate the amylotic ferment, and this approximately in proportion to the extent in which they are present in the natural secretion; while of the reducing gases, hydrogen retards and hydrogen sulphate stimulates. In a fourth memoir, by the Editor and S. E. Allen, the subject is the influence of various inorganic and alkaloid salts on the proteolytic action of pepsin-hydrochloric acid. In this the comparative influence on gastric digestion of various metallic salts well known as poisons or therapeutic agents has been studied, and some experiments on some alkaloid salts are added. The subject of the influence of temperature on the relative amylotic action of saliva and the diastase of malt is treated of by the Editor and Dr. W. E. Martin. The influence of various therapeutic and toxic substances on the proteolytic action of the pancreatic ferment, and on the influence of bile, bile salts, and bile acids on amylotic and proteolytic action are investigated in two memoirs by the Editor and Dr. Cummins. There is a very interesting, and, from a medico-legal point of view, important memoir on the absorption of arsenic by the brain tissues, by the Editor and Dr. Herbert E. Smith. Two memoirs on the influence of potassium and ammonium bromides, and on cinchonidine sulphate on metabolism, are by the Editor and Dr. W. Culbert, and the Editor and Dr. Henry Whitehouse; while a memoir on the *post-mortem* formation of sugar in the liver in the presence of peptones, by the Editor and Dr. Alex. Lambert, concludes a volume which in many ways reflects great credit on the work done at Yale College, and shows an intimate knowledge of the labours in the same direction of the authors' fellow-workmen in Europe.

Catalogue of the Lizards in the British Museum (Natural History). 2nd Edition. By George Albert Boulenger. Vol. II.

THE rapid progress made with this important Catalogue shows an amount of energy on which the authorities of the British Museum and herpetologists generally may be congratulated. The first volume appeared early in 1885, and was noticed in NATURE for May 21 (vol. xxxii. p. 49); the second volume was issued before the conclusion of the year.

This volume contains the following families of lizards: Iguanidæ, with 293 species; Xenosauridæ, with 1; Zonuridæ, 14; Anguidæ, 44; Anniellidæ, 2; Helodermatidæ, 3; Varanidæ, 27; Xantusiidæ, 4; Teiidæ, 108; and Amphisbænidæ, 65; or a total of 561 species, distributed amongst 115 genera. The number of species is consequently rather greater than in the first volume, which contained descriptions of 490. In the present as in the preceding volume several genera proposed by previous writers are united into larger generic groups: thus in the Varanidæ only one genus, Varanus, is recognised in place of the seven into which the family was divided in Dr. Gray's Catalogue of 1845. Five new genera are proposed—three in the Iguanidæ and two in the Teiidæ. The construction of one of the names proposed, Enyalioides, is, however, unfortunate, as the termination, that of an adjective, is objected to by many naturalists, and there is consequently the risk of another term being proposed.

Nearly all the Iguanidæ and all the Teiidæ are American, and as these two families contain between them 401 species out of the total number described in the volume there is a great preponderance of types peculiar to the New World. Two of the exceptions to the prevailing American distribution in the case of the Iguanidæ, the genera Chalarodon and Hoplurus, are peculiar to Madagascar, although no species of the family has been discovered in Africa.

The lithographic plates attached to both this and the previous volume are excellent, and the figures of lizards, even if not quite so life-like as the highly artistic drawings of the late Mr. Ford, are far superior to the illustrations usually found in works on Reptilia. W. T. B.

Physikalische Krystallographie und Einleitung in die krystallographische Kenntniss der wichtigeren Substanzen. Von P. Groth. 2nd Edition. (Leipzig: Wilhelm Engelmann, 1885.)

THIS is the most satisfactory work of its kind which has been published in any language. In a very simple way the chemist is made to comprehend the mysteries of geometrical crystallography, the physicist is taught how intimately optical and other physical characters are related to crystalline form, while to the microscopical petrographer is presented a careful explanation of the principles upon which all his determinations must be based. We are glad to see that in this edition the simple notation of the late Prof. Miller, of Cambridge, reigns almost supreme; doubtless, it will soon succeed in driving its unpronounceable rivals completely from the field, to the relief of every student. Stereographic projection too takes a very prominent place. In the present edition the work has been increased by 180 pages, most of which are given to the chapter descriptive of the instruments: there are as many as 631 woodcuts. We wish this edition all the success it deserves.

The Rudiments of Mineralogy. By Alexander Ramsay, F.G.S., &c. Third Edition. (London: Crosby Lockwood & Co., 1885.)

MR. RAMSAY is far from being a master of his subject. We cannot imagine what advantage the elementary student, for whom the book is intended, can derive from information as to the specific gravity of each species relative to *hydrogen*: in the case of native silver, for example, he is told that the specific gravity ranges from 115,123 to 117,369! And in any case what is the experimental value of the last three or four figures? The specific gravity of each species relative to water is given as usual, so that the reference to hydrogen is only an additional torment for the learner. We doubt too the wisdom of explaining specific and atomic heats, and giving lists of their values. Isomorphism and pseudomorphism are hopelessly confused and interchanged on p. 20, while the illustrative formula is quite unintelligible. The adjusting apparatus of the ungraduated goniometer is, as usual in text-books, wrongly disposed for use. We have noticed several mistakes of fact and errors of printing; but the book is neat in style, and perhaps will not do much harm.

The Prospector's Handbook. By J. W. Anderson, M.A., F.R.G.S. 8vo, pp. 132. (London: Crosby Lockwood and Co., 1886.)

THE author, after traversing the mineral fields of New Zealand, New Caledonia, New Mexico, and Colorado, feels convinced that some simple guide or handbook for the use of prospectors as well as travellers is a desideratum, and the present volume is the outcome of this conviction. It contains a number of notes or paragraphs upon subjects incidental to metallic mining, which are distributed into chapters under the different heads of prospecting, rocks, blowpipe-testing, character of minerals, metals, and metallic ores, other useful minerals and ores, composition of various rocks, testing by the wet process, assay of ores, and surveying; to which are added an appendix of tables and a glossary of terms. As the whole text is contained in rather more than a hundred pages, not very closely printed, it will be easily understood that no one of the numerous subjects included in the author's programme is very thoroughly treated. The best part of the book is the introductory chapter on prospecting, which contains some useful generalisations on mineral deposits and the search for them, which, however, are more likely to be of use to the "tender-foot" than to the prospector properly so called. It would seem, however, that this is what the author has in contemplation, as, from some remarks on p. 9, he appears to consider prospectors and miners as two different classes of men, and evidently has no very favourable opinion of the latter. Our own experience points in the opposite direction and leads us to regard typical prospectors as representing the highest and most intelligent class of operative miners. Unfortunately it is difficult to keep them on regular mining works except during the winter time, when the mountain regions are inaccessible.

The remainder of the book is of very little value. The descriptions of minerals are short, without being clear, and in many cases far from accurate. Thus, the composition of galena is stated to be "80 per cent. of lead, the rest sulphur"; malachite is said to contain 70 per cent. of copper, and silicate of zinc about 67 per cent. of zinc. All of these statements are incorrect, and it is not easy to see why they have been made, as no more space would have been required to give the composition corresponding to the theoretical constitution.

The sections on assaying and analysis are not likely to be required by the prospector in the field, and are too vague to be of much use to sedentary students. A description of the methods adopted in sampling gold and silver-bearing vein-stuff in the Western States and Territories of America would have been of interest, but we find no notice of this or any analogous practice followed elsewhere.

The glossary at the end contains several curious definitions, many of which, however, are reproduced from previously published works. The description of the term "tribute" more properly applies to dues or royalty rents as understood in this country. It may be that the author's definition applies to some local foreign usage, but this is not stated. H. B.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Hereditary Stature

PERMIT me to correct one word in my memoir on "Hereditary Stature" in the last number of NATURE (p. 297, col. 1, line 6 from bottom), which should read "seven" on an average. I should be glad at the same time to amplify the passage in which it occurs, as follows:—

The chance that the stature of the son will at least rival the stature of the father, is not uniform; it varies with the height of the father. When he is of mediocre stature, that is, 5 feet 8¼ inches, out of every 100 sons born to a group of fathers of that height, 50 will be taller and 50 will be shorter than their fathers (the practically impossible case of absolute equality being neglected). Here then the chance of which we are speaking = 50 per cent. When the father is tall, the chance in question diminishes; when he is very tall, say 6 feet 5 inches, the chance is reduced to seven per thousand. The following table shows the probabilities in various cases. Columns A contain the height of the fathers, Columns B show how many per cent. of the sons will rival or surpass the height of their fathers:—

A ft. in.	B per cent.	A ft. in.	B per cent.	A ft. in.	B per cent.
5 8¼	50	6 0	15	6 4	1·4
5 9	42	6 1	9	6 5	0·7
5 10	31	6 2	5	6 6	0·3
5 11	22	6 3	3		

FRANCIS GALTON

Deposits of the Nile Delta

TWO communications from Sir William Dawson, published in NATURE of January 7 and 28 (pp. 221, 298), appear to call for a short notice from me. The report on the above subject which I read before the Royal Society on November 19, 1885, and of which an abstract appeared in NATURE of December 10, ought not to be referred to as "the report of the Delta Committee of the Royal Society." The origin of this report was as follows:—As there was no other geological laboratory available for the examination of the samples of delta-deposits sent home by Col. Maitland than the one connected with the Normal School of Science and Royal School of Mines, the other members of the Delta Committee requested me to undertake the microscopical and chemical investigation of the specimens. In preparing my report on them I was struck by the remarkable and unexpected characters which they presented, and I ventured to suggest a mode of accounting for them. When my report was submitted to the Committee I was requested to lay it before the Society; and, it would seem quite superfluous to add, neither the Committee nor the Society thereby accepted any responsibility for the views which I expressed in the report.

As Sir William Dawson lies under a manifest disadvantage in attempting to criticise a report which he has not seen, it will not be necessary to enter at length upon the subject of his communications. If I understand the first of these aright, he takes the opportunity in it of withdrawing his untenable assertion that "at a depth of 30 or 40 feet the alluvial mud rests on desert sand" in favour of the *totally different* statement that "the modern Nile mud" lies on "a Pleistocene or Isthmian deposit." In the absence of any palæontological evidence I can offer no opinion as to the truth of this latter view; but it is certain that the deposits above and below the limit mentioned are of precisely similar mineral characters. With respect to the second communication, I need only add that when its author has the opportunity of reading the report in question, he will find that the very obvious considerations to which he refers have been by no means lost sight of. JOHN W. JUDD

Stone Implements and Changes of Level in the Nile Basin

I INCLOSE a letter from my brother at Wady Halfa. The scrapers sent home are all made out of flat oval pebbles of jasper, one side of which is left untouched, while the other is all chipped away except a small central area; most of them are unfinished. The few implements found among the quartz chips are very rough, and may be classed as lance-heads. The smaller pebbles of agate and carnelian seem to have been broken up in great numbers to obtain, out of the interior flakes, small articles about the length of the thumb-nail, of two types, pointed and rounded.

There is one doubly-pointed arrow-head of jaspar carefully finished like Fig. 299 in Evans's "Stone Implements." Also several rough implements of larger size of impure basalt. Many of the hammer-stones are very characteristic, and have been much used. Others show the effect of attrition by sand, &c., as in those from the Irish sand-hills. F. ARCHER

Crosby, Liverpool, January 30

Wady Halfa, January 2, 1886

SIR,—When serving in the Soudan last winter, in the occasional walks I was able to take in the Desert I kept a look out for stone implements, but failed to find any until I reached Abri, where I picked up on the beach a well-worked flake, but much worn, of Egyptian jaspar.

Shortly after my arrival here I found several scrapers in the plain lying between the river and the hills, and more extended search led me to further discoveries. The hills at Wady Halfa, which are of sandstone capped with trap (?), are distant about a mile and a half from the present banks of the river, but at a bend of the Nile about eight miles below our camp the valley narrows, and the cliffs rise almost perpendicularly from the water's edge. To the south it widens to the extent of some six or eight miles between the hills on either bank. The whole of the plain between the sandstone ridges is covered with a deposit of Nile mud of unknown depth, but on the right bank this is to a great extent concealed by the sand and pebbles brought down in past ages by the river. The ground is uneven, here and there rising to mounds of hardened mud. There is, however, a gradual though slight rise towards the hills. Soon after my arrival I picked up a number of flakes of quartz, and found that they were most numerous in a belt of dried mud about half a mile distant from the river and a quarter of a mile in width, and tracing this northward I found a mound, some acres in extent, formed of mud and completely covered with sand and tons of chips of quartz, and also of agate, onyx, carnelian, and other hard stones. It was evidently the site of an ancient manufactory, and on this spot, in the many visits I have since paid to it, I have got numerous more or less well-fashioned specimens. Stone hammers may be picked up by the dozen, and these are made of many different minerals. The most interesting are those formed of silicified wood, of which large blocks, curiously polished by the action of the water and sand, are still lying on the river's bank. Tracing the belt further, I have found, both north and south of the camp for many miles, chips and hammers more or less abundant, and little water-worn. I have reason to think that the same is the case on the left bank.

Rambles in the desert, and search among the debris brought down by the Nile in former times were rewarded by the discovery of many roughly-worked flakes, evidently of much earlier date, being very much water-worn. These were widely scattered over the desert, being nowhere abundant. The highest point at which I found them was on the summit of a gravel-covered mound about 50 feet above the present level of the river.

A proof of the Nile having in former times flowed at a much higher level than it does at present, is found in the fact that valves of the peculiar Nile bivalve, *Ætheria*, may still be seen *attached* to the rock close to the foot of the hills, and at an elevation of some 30 feet above the present bank. As this shell must necessarily have lived always under water, the rocks when they are found must formerly have been part of the river-bed. If then as now the difference in height between high and low Nile amounted to 40 feet, it is evident that when the shells were living the stream flowed 60 to 70 feet higher than it now does. Whether the stream has receded or the land been elevated I am unable to decide.

It is stated in Murray's Handbook—I know not on what authority—that there is an inscription at Sannek, 35 miles south of Wady Halfa, which records that in the reign of Amenanhat III. of the twelfth dynasty, the Nile at that place rose to a point 27 feet 3 inches higher than it does at the present time. If this is the case and if the same were true as regards the river at this place, the implements and chips found in the belt previously mentioned are of a date subsequent to the reign of that king. I have found some hammers and flakes in the plain not far from the Nile, and very little above its present level.

If any traveller is desirous of obtaining specimens from this neighbourhood he will find a landmark in the British Military Cemetery, from which point the strip of desert in which the remains are most abundant may be traced north or south. The mound of chips is about a mile to the north of the graveyard overlooking an ancient water-course. S. ARCHER

P.S.—Since writing the above I have found another small mound with quartz flakes only between the Nile and the railway.

Parallel Roads in Norway

PARALLEL roads in Norway, such as those described by Mr. Hansen in your last number (p. 268), have already attracted the attention of several British geologists. Robert Chambers, a careful observer, saw and described them as long ago as 1849. His description, however (*Edinburgh Philosophical Journal*, vol. xlviii. p. 71), seems to be unknown abroad, and is not generally accessible anywhere. With your leave, therefore, I quote it entire.

"The valley of the Laugen, for several miles down, contains great masses of pure sand in the form of terraces and isolated mounts. On one of the latter Dovre Church is situated. . . . In this portion of the valley there is a terrace unlike the rest, in as far as it is a narrow ledge of detrital matter, running continuously along the hill-side for fully fourteen miles, however much more, while the terraces resting on the skirts of the hills lower down are great projecting masses, seldom extending far on one level. This remarkable terrace is most conspicuous on the south-west side of the valley. It begins on that side at Oue, between the Hougen and Tofte post-stations. It is there seen truncating the prominent ancient delta of a side stream, called, in Prof. Munch's map, the Jondals Elv, several hundred feet above the bottom of the valley. As we ascend the valley, it becomes nearer to our eye, but this is only because we rise to it, for, when examined with a correct instrument from its own elevation on the opposite side, it is proved to be for a great way truly horizontal. On the north-east side of the valley the corresponding mark is a line composed of slight projecting banks of water-laid sand. Though not continuous, this line is sufficient to have determined that of a long mountain-path connecting a series of farms. Beyond Lie post-station the road to Molde passes along it, and it here affords positions for a close series of hamlets, which make a conspicuous appearance in the map above cited. I believe it is nearly, if not exactly, of the same elevation with the little *hof*, called Dombaas, of which the height is given by Prof. Naumann as 2162 (English) feet. In its relation to the lakes in the summit between the two valleys (*i.e.* of Laugen and Rauma) it precisely resembles the lowest of the Inverness-shire *parallel roads*, as exemplified in Glen Spean, where advancing to the basin of Loch Laggan, between the Spean and Spey valleys. The terrace in every other respect bears a strong resemblance to the Inverness-shire *roads*, while in some important respects, as already noted, it differs from other terraces. I should much desire to see it obtain the attention of local observers, by whom its internal constitution and other features could be more particularly ascertained."

I offer this extract the more readily that the observations of the paper in which the passage occurs ("On Changes in the Relative Level of Sea and Land in Scandinavia") have scarcely received the attention, among Norwegian geologists, to which their care entitles them. Chambers further refers to the same terrace, in a descriptive and popular way, in his "Tracings in the North of Europe," a little volume reprinted (for distribution, fifty copies only) from *Chambers's Journal* in 1850. You will perhaps allow me to add this short reference to the other.

"In addition to the many sandy terraces at different and indeterminate heights, I discovered one of a much more remarkable character, passing along both sides of the valley for fully twenty miles, always at one elevation, and specifically identical as a terrace with the celebrated *roads* of Glenroy in Inverness-shire. It first became visible at a place called Oue (pronounced Ouya) on the west side of the valley, where it truncates the ancient delta of a side stream far up the mountain-side. It is seen thence passing along through the scraggy woods without any interruption, till, on our turning out of the valley, we lose sight of it among the high grounds near Lässö Lake.

On the east side of the valley, perhaps 150 feet above the level of the road at Lie Station, I could distinctly trace this terrace by its hummocks of water-laid sand, and the farmhouses perched on its favourable points. A long series of hamlets on the road to Molde is placed upon it. As an object in physical geography, in its form, its uniform level on both sides of the vale, and its relation to the lakes at the summit-level, this terrace precisely resembles the lowest of the Glenroy terraces as it approaches Loch Laggan. It must, however, be more than twice the level above the sea" (p. 105). Chambers, of course, viewed it as an ancient sea-margin.

The same long terrace was also seen by my colleague, Mr. J. R. Dakyns, in 1872, and described (without reference to Chambers) in the *Geological Magazine*, 1877, p. 74. "If the terrace is on a level," he says, "with the watershed, and there is certainly no great difference between them, one is irresistibly led to think of the similar case of the parallel roads of Glenroy, and . . . of a gigantic Marjelen See dammed back by ice till it overflowed the summit of the pass at Molmen. It is significant that I could see no trace of terrace or water-mark on the Romsdal side of the pass. There is in the same district a second horizontal mark on the solid rock, several hundred feet higher than the 2000-feet one. This, too, seems to correspond with sand-terraces in the recesses of the high glens. . . . Here again it is striking that the water-mark should seem to correspond with the level of a watershed."

I myself saw Chambers's striking terrace in 1873. But I have nothing to add to the observations above quoted, and I make no claim whatever to have my name connected with them. But I may remark the fact that the little deltas or alluvial cones of the streams, where these cross the terraces, so conspicuously bear reference to the surface of the vanished sheet of water in which they were formed, as to remind one how greatly similar evidence was relied on by Darwin as demonstrating the *aqueous* origin of the roads of Glenroy. Mr. Hansen's discovery of parallel roads at the head of the Glommen and in Jemtland is very interesting, and I hope he will find time to study and *map* them in detail.

HUGH MILLER

51, Lauriston Place, Edinburgh, January 24

Meteorological Phenomena

ON January 4 last, while watching a very bright rainbow with a good secondary from Hoylake racecourse, I observed between the two bows a third, fainter than either, touching the primary at the base and extending upwards in such a way that probably, had it all been visible, it would have touched the secondary at the vertex. It was not all visible because of a break in the clouds. Its colours were in the same order as those of the primary, red outside. This third bow was only visible at one side; but a gentleman who observed it stated that he had seen it before, and symmetrical on both sides, though not extending to the vertex.

Another phenomenon I have observed here some time ago. A fall of hail lasting a few minutes occurred, the hailstones being exact cubes, of size about 7 mm. and of consistency like lumps of salt.

JOHN C. WILLIS

University College, Liverpool, February 1

M. BARRÉ DE SAINT-VENANT

"WE have now to consider the earlier work of the greatest of living elasticians." Within a fortnight after these words were sent to the press, on January 6, M. de Saint-Venant died at Vendôme. The news of his death will have caused a deep feeling of regret among English mathematicians and physicists, to whom his researches are so well known that they have attained in their own field a classical value. We purpose in this notice to give some brief account of this foremost representative of latter-day French mathematical physicists.

Saint-Venant stood out for the younger mathematicians of the English school, as the link between the past and the present. Intimately related to the great period of French mathematical physics, he had continued to produce down to our own day, and we felt him to be as real a personality as Helmholtz or Thomson. A younger member of the school of Poisson, Navier, and Cauchy, he had yet lived to "edit" Clebsch. Deputy for Coriolis at the École des Ponts et Chaussées in 1837, Saint-Venant early received public recognition for his work from Poncelet in his lectures at the Sorbonne in 1840; within the next few years he corrected Cauchy's theory of torsion, and saw his correction accepted by the author of the "Exercices des mathématiques." More than forty years afterwards he "edits" what will long remain the standard treatise on elasticity—the annotated French translation of Clebsch. Thus his work is spread without a break across the middle fifty years of our century; he took up elasticity where Poisson had left it—a mathematical theory; he leaves it one of the most powerful branches of mathematics applied to physics and practical engineering; not a small amount of this transformation is due directly to his researches, or indirectly to his influence.

Turning to the personal character of the man, we find in him the essential characteristics of the scholar and the student, the truest modesty, the complete absence of self, the single-minded devotion to his study. Saint-Venant, whose researches on elasticity undoubtedly far surpass those of Navier and Clebsch, is yet content to appear as their *editor*. But what an editing it is! The original text is hidden, disappears, almost as completely as Peter the Lombard's "Sententia" in a mediæval commentary. It is Saint-Venant's notes, appendices, and corrections, which form the value of these works, which make the third edition of Navier's "Leçons" the standard treatise on the strength of materials, and the French translation of Clebsch the foremost work on mathematical elasticity. Nay, he even praises Clebsch for inventing a term in 1862, which he himself had first proposed in the privately distributed lithographed sheets of 1837! Ever ready with advice and assistance, perfectly free from jealousy, Saint-Venant was a typical scholar. We had occasion, scarcely six months ago, to apply to him for assistance with regard to some of his earlier work. Within a few days we received a packet containing twenty-three of his memoirs, all carefully corrected, and many annotated. He expressed a lively interest in the progress of the "History of the Mathematical Theories of Elasticity," lending the editor of that work several French lithographed courses which were otherwise inaccessible, and accompanying them by letters which amounted almost to a dissertation on the history of elasticity.

"Je desire, bien cher monsieur, que ces quelques renseignements et documents puissent servir à l'utile travail historique que vous avez entrepris, et dont j'apprendrai avec plaisir la publication ainsi que le nom de l'éditeur. J'en verrais même avec plaisir les épreuves."

Shortly before Christmas we received from Saint-Venant corrections for the first three sheets of Dr. Todhunter's ninth chapter, which is devoted to Saint-Venant's earlier work. On January 3 we sent him the remaining proofs of that chapter; a week afterwards we had to mourn the loss of one whose personal kindness had served to intensify the respect raised by his transcendent mathematical ability.

If we examine the leading characteristics of Saint-Venant's scientific work we find them marked by an essentially practical character. We find subtlety of analysis combined always with practical physical conceptions. The problems he attacks are those which are physically possible, or of which the solution is an immediate practical need. He smiles good-naturedly over Lamé's attempts to solve the terrible problem of an elastic solid in the form of a right-six-face, whose surface is subjected to any system of load. The solution would be a triumph of analysis, but its physical and practical value would in all probability be *nil*. He chooses instead a *real* beam, and he obtains a solution which, if it be but approximate, is at least an approximation to reality, and will serve all practical purposes. Saint-Venant never troubled himself with impossible distributions of load over impossible surfaces, but took the problems of mechanics as they occurred practically, and solved them for practical purposes. This tendency on his part was no doubt greatly due to his training as an engineer. He was Ingénieur-en-chef des Ponts et Chaussées; he had been Professeur de Génie rural à l'Institut agronomique; he had built lock-gates and improved the gutters of Paris; he was an authority on agricultural drainage, and had investigated the best form of the ploughshare; he designed a bridge for the Creuse, and planned a method, afterwards adopted, for drying up the vast marshes of the Sologne. Yet with all this he was a great master of analysis, and knew how to make his analysis fruitful in practice.

It is not our purpose here to give a bibliographical account[1] of Saint-Venant's works; we wish only to sketch the general scope of his researches, and shall confine ourselves to indicating the more important advances he has made in his own peculiar subject—that of elasticity. The first important work by Saint-Venant is the "Cours lithographée" of 1837. This consists of lithographed sheets given to the students of the École des Ponts. A few years previously Vicat had made his crushing attack upon the accepted mathematical—the Bernoulli-Eulerian—theory of beams. Here we find this attack justified and replied to by the introduction of the neglected slide (*glissement*) into the theory, and its application to a number of practical problems. Here, too, we see for the first time the true limit of elasticity expressed by a strain, and not a stress, maximum. This is a correction of the old theory which is of primary practical importance, although the old theory is still to be found in many English practical books, and even in such a theoretical authority as the German Clebsch.

A thorough appreciation of the true relation of theory to practice is evidenced by the following lines, which should be taken to heart by every technical teacher:—

"L'usage des mathématiques cessera de s'attirer des reproches si on le referme dans ses vrais limites. Le calcul pur est simplement un instrument logique tirant des conséquences rigoureuses de prémisses posées et souvent contestables. La mécanique y joint bien quelques principes physiques que l'expérience a mis hors de contestation, mais elle laisse aux expériences particulières le soin de déterminer quelles forces sont en jeu dans chaque cas, et il règne toujours à cet égard plus ou moins d'incertitude qui affecte nécessairement les résultats. Ces résultats ne doivent point être considérés comme les oracles, dictant infailliblement ce que l'on doit décider; ce sont de simples renseignements, comme les dépositions de témoins ou les rapports d'experts dans les affaires judiciaires, mais des renseignements extrêmement précieux et dont on ne doit jamais se priver, car il est extrêmement utile à la détermination que l'on a à prendre, de connaître la solution exacte d'un problème fort rapproché de celui qui est proposé, et de pouvoir se dire, par exemple, 'si les efforts étaient exactement tels ou tels, les dimensions à donner seraient telles ou telles.' De cette manière le champ de *l'appréciation instinctive* se trouvera réduit aux différences qui ne peuvent pas être le sujet du calcul théorique; et l'on voit que ces deux méthodes, loin de s'exclure, peuvent concourir ensemble, se suppléer et s'aider mutuellement, se contrôler même quelquefois,—enfin contracter sous les auspices du bon sens, une alliance féconde en résultats utiles sous le double rapport de la convenance et de l'économie."

These words represent exactly the spirit with which Saint-Venant entered upon the important investigations of later years. Of other earlier work of Saint-Venant, we may especially note the series of papers in the *Comptes rendus* for 1840-50. These contain the rectification of the theory of elastic rods by the introduction of the third moment in the case of inertial æolotropy in the section,[1] the complete equations for spiral springs, and the first rectification of the theory of torsion by the discovery of the distortion of the primitively plane section. These researches are all epoch-making in the theory of elasticity. To the next decade belong the classical memoirs on "Torsion" and "Flexure," the complete treatment of torsion on the basis of the distortion of the plane sections, and the complete treatment of flexure by the consideration of slide. The beautiful diagrams of the contour lines are known to all students of physics, if not from the original memoirs, at least from the "Treatise on Natural Philosophy" of Thomson and Tait. The very perfect plaster models prepared under the direction of Saint-Venant to illustrate flexure, torsion, and resilience, are less generally known,[2] but for teaching purposes they are of even greater value than the diagrams. In addition to these *opera maxima* we may mention the important researches on impact, belonging to the same period (Société Philomatique, 1853 and 1854). The decade received its final touch in the first volume of Saint-Venant's edition of Navier's "Leçons." This volume presents the first history of elasticity in the brief but luminous "Historique abrégé."

The last period of Saint-Venant's work contains the all-important memoirs on the distribution of elasticity in æolotropic bodies, on the various types of homogeneity, further researches on longitudinal impact, the tract on the undulatory theory of light, the second volume of Navier's "Leçons," the treatise on elasticity in Moigno's "Statique," and, amid a variety of *opuscula*, to crown the work of a life, the annotated edition of Clebsch's "Theorie der Elasticität." The original "Clebsch" contains 420 pages, the annotated translation with a much larger page has more than 900 pages. When will an English elastician arise, who will annotate Saint-Venant as Saint-Venant has annotated Clebsch?

One word more with regard to Saint-Venant's position as an elastician. In England the controversy over the number of elastic constants seems to have been decided in favour of multi-constancy. Saint-Venant was, and remained to his death, a supporter of the French, or rari-constant, hypothesis. The experiments, he argued, upon which the multi-constant elasticians based their theory were not made on truly elastic bodies, or were made upon bodies like wires and plates which are not isotropic. Into his treatment of such bodies he introduced, not the two constants of isotropy, but the constants of a cylindrical or planar distribution of homogeneity. Being written to last September on this point, he replied:—

"Vous voulez bien me demander si je conserve les mêmes opinions que j'ai exprimées et longuement developpées à l'appendix V. de mon édition de Navier, à savoir, la réduction des coefficients des formules d'élasticité à *un seul* (où $\lambda = \mu$ dans les formules de Lamé); ce qui conduit d'après le même principe que chaque action entre deux molecules est fonction de leur seule distance mutuelle, à réduire pour la contexture hétérotrope le plus générale, et à ne reconnaître que 15 coefficients distincts et non pas 21.

"Je reponds *oui* pour les vrais solides (supposés isotropes) comme sont les métaux ordinairement, ainsi que le marbre, le verre; mais *non* si l'on veut absolument par un motif quelconque que je ne conçois guère, appliquer les formules de l'élasticité au caoutchouc, aux gommes molles, aux gelées, et aux autres corps mous et élastiques, car ces corps-là ne sont que des mélanges de tissues cellulaires, de membranes élastiques, et de fluides visqueux que leurs cellules contiennent."

[1] A bibliography of his memoirs relating to elasticity and the strength of materials will be given in the "History of Elasticity." A complete bibliography to 1864 will be found in "Notice sur les travaux . . . de M. de Saint-Venant," Paris, 1864. This is brought up to 1885 with partial completeness in the copy presented to us by Saint-Venant himself.

[1] He shares the honour of this discovery with Bellavitis.

[2] We have a copy of the whole collection at University College.

Perhaps the constant-controversy is not quite so obviously settled as some English physicists seem to think. But, however the future may regard it, history will record that on January 6 of this year died one of the greatest mathematical physicists and undoubtedly the greatest elastician that Europe has seen since the age of Poisson and Cauchy. KARL PEARSON

ON SOME INTERESTING CASES OF MIGRATIONS OF MARINE FISHES, ON THE COAST OF VENEZUELA AT CARUPANO

CARÚPANO is a thriving seaport on the northern coast of Venezuela, midway between the peninsulas of Araya and Paria, in lat. $10^\circ\ 14'\ 15''$ N., and long. $63^\circ\ 18'$ W. from Greenwich, and therefore in close vicinity to the channel which leads from the Atlantic into the Caribbean Sea between Tobago and Grenada on the one side, and Trinidad and the South American mainland on the other side. Through this channel enters the great western current of the Caribbean Sea, running at the rate of about one mile and a half an hour, though not with much regularity. The coast-line forms the western prolongation of the northern shore of Trinidad, trending almost due west. The water is rather shallow to a considerable distance from the land, the 100-fathom line due north of Carúpano being about 60 miles off the shore,[1] which gives for the sea-bottom a gradient of but 1·67 per 1000.[2]

Such are, in a few words, the general hydrographic conditions of that locality, famous in this country for the frequent occurrence of immense shoals of fish of different kinds, which, either alive or dead, are finally thrown by the surf on the beach. The inhabitants call the shoals *ribazones* when the fish arrive alive; in the other case they are called *turbios*, on account of the turbid appearance the sea presents in such circumstances.

Though the *ribazones* may occur at any time of the year, it appears that there is a greater probability of their advent during the rainy season, or from May to November. The weather must be fine, with a moderate breeze from the sea. The shoals are composed of a great many different species; most of the fish are, however, of small size. They are followed by large numbers of predatory denizens of the deep, sharks being generally prominent amongst them. In some cases the presence of whales has been recorded; it is undoubtedly the cachalot (*Catodon macrocephalus*), which occasionally visits the Caribbean Sea.[3] At the same time large flights of sea-gulls accompany the shoal, picking up a considerable number of fish, and, with their deafening shrieks and endless whirls, adding to the picturesque vividness of the scene. Owing to these manifold persecutions the frightened fish make towards the shallow water of the shore in such haste and with such impetuosity that the sea is almost boiling with foam for many miles. Most of the fish are still alive when they reach the beach, where the inhabitants, gathered in large crowds, are not slow in securing as many as they are able to carry away. By far the greatest number die on the shore, however, and their remains form a true *cordon littoral*, several feet in width and height, which soon fills the air with a most offensive smell.

1 "Deep-Sea Soundings in the Gulf of Mexico and Caribbean Sea" (Chart No. 21 in *Report* of the U.S. Coast and Geodetic Survey, 1881, Washington, 1883).

2 I take the nautical mile, equal to one-sixtieth part of the length of a degree on the great circle of a sphere whose surface is equal to the surface of the earth = 1853·248m. or 6080·70 feet (J. E. Hilgard, "On the Length of the Nautical Mile," in the *Report* mentioned in the foregoing note, pp. 354-356).

3 There is in the Museo Nacional of Caracas a tooth of this species, from a specimen which was stranded some years ago on the shores of Margarita. I saw myself, in 1873, another whale, but only for about one minute, in the sea between the islands of Tortuga and Margarita. The animal swam with its mouth wide open and the head partially raised above the surface of the water. The upper jaw was small and narrow, so that it certainly was not a cachalot. Though I could not see the back, I supposed then it might be a Balænoptera, perhaps *B. rostrata*. However, I do not know whether this species comes so far to the south.

The latest *ribazon* occurred on the morning of Oct. 10 last. The shoal seems to have come from the north-west, and was extraordinarily large. It contained such species as the "pargo" (*Lutjanus profundus*, Poey, the same as *Mesoprion aya*, Cuv. and Val.), which, as I am informed, had never been observed in any other *ribazon*. The Royal Mail-steamer *Severn*, going eastward at a speed of about eight miles an hour, was for two hours (from seven to nine in the morning) literally cutting through the shoal, and as she struck its main course at an angle of 45°, approximately, the breadth of the shoal must have been ten miles at least.[1] The shoal finally ran on shore to the east of Carúpano, and such was the quantity of stranded fish, especially between the places called Hernan Vazquez and Guayacan, that the local authorities deemed it necessary to summon a large number of workmen, in order to have trenches dug in which to bury the dead fish.

With respect to the causes of these migrations, I think they cannot differ from those which give rise to the well-known migrations of marine fish in other parts, the search for food being no doubt the most important. The waters of the great western Caribbean current are richer in food than the comparatively quiet part of the sea north of the current. The fish travel, therefore, in this direction, and attract of course a gradually increasing number of their enemies. On the coast of Carúpano the fisheries are insignificant, and thus the shoals are not disturbed in their migrations until they reach the shore. Farther to the west, in the waters of Margarita, the case is different, the large fishery establishments of this island having constantly boats and crews in readiness to intercept the shoals, as soon as their arrival is announced by the fire-and-smoke signals of the look-out men stationed on the different headlands and other places known to be favourably situated. With regard to Carúpano, it is certainly a great pity that the fisheries are so neglected that every year a large amount of what ought to be a rich harvest is lost, and left to turn into noxious and fever-breeding carrion.

The *turbios* are *ribazones* during the arrival of which submarine eruptions of deleterious gases, principally sulphuretted hydrogen, happen to break out, so that the fish are killed before they reach the shore, the water at the same time becoming turbid with the mud from the bottom, which is violently stirred up by the outbreak of the gas. The quantity of the latter must be very considerable indeed, as the foul smell on such occasions is noticed all over land and sea.

Gaseous eruptions of the same nature, as well as sulphurous springs, are not at all uncommon in the neighbourhood of Carúpano; the two *azufrales*, about twenty miles to the south of the town, being the most important.[2] The whole region, in fact, was at the end of the Tertiary period the theatre of a great geological catastrophe, when the Golfo Triste was formed by a sudden subsidence, which was also the origin of the so-called delta of the Orinoco,[3] the Gulf of Cariaco, and the many lagoons in the provinces of Cumaná and Maturin. At the same time extensive tracts of land were submerged to the north of the mountains which run through the whole length of the peninsulas of Araya

1 From information given to me by Señor Bastardo, a medical student at our University, who was a passenger on board the *Severn*.

2 Wall and Sawkins, "Report on the Geology of Trinidad," London, 1860, p. 198.

3 The Orinoco has no delta in the true geological sense of this word, as the land comprised between the outer branches of the intricate fluviatile plexus of its mouth has *not* been formed by the river. The southern branch is the old river channel; when the above-mentioned subsidence took place, the land on the left bank sank gradually towards the north, and part of the waters, following the new slope of this northern plane, cut into it the different channels with their connecting branches which, after a slow and tortuous course, empty into the sea between the old mouth of the river and the southern entrance of the Golfo Triste.

and Paria, and thus the Sea of Carúpano was formed. That the South American mainland extended before this catastrophe as far as Grenada, Tobago, and Trinidad, is sufficiently proved by the investigations of Mr. Bland on the land shell fauna of the West Indies, and is moreover corroborated by the comparative shallowness of the sea between the coast of Venezuela and the islands mentioned. Tobago is still within the 100-fathom line, and a rise of the sea-bottom of no more than 400 fathoms would be sufficient to re-establish the terrestrial connection with Grenada.[1]

It is self-evident that an immense quantity of organic matter must have been buried with the sunken land. This organic matter contributes to the formation of sulphuretted hydrogen, and is the stratum which feeds the submarine petroleum springs on the coast of Barcelona: whilst in those parts which afterwards were again lifted above the surface of the sea, it appears in the extensive deposits of asphalt known in Trinidad and Maturin, and performs an active part in the generation of the sulphurous vapours of the *azufrales*.

If we consider what a large quantity of fish-remains must gradually accumulate in the shallow waters on the coast of Carúpano, where they are slowly covered by successive layers of finely-sifted sediment, we are enabled to understand how other deposits of a similar character, for instance, that of Monte Bolca, have been formed in bygone ages; indeed, Carúpano will, in time, be another Monte Bolca to the palæontologist of the Coming Race.

Caracas University, October 22 A. Ernst

KILIMA-NJARO[2]

The rapid progress of African exploration during the last quarter of a century is strikingly exemplified in the brief history of the monarch of African Mountains. Doubtfully alluded to as the "Ethiopian Mount Olympus" by Enciso in the sixteenth century, and absolutely unknown to science before its discovery by Rebmann in 1848, it has already since that year been several times visited, partly explored, and even ascended to heights of 10,000 and 14,000 feet by Baron von der Decken in 1861-62, by the Rev. Charles New in 1871, and by Mr. Joseph Thomson on his memorable journey "Through Masai Land" in 1883. And the work of these pioneers has now been all but completed by Mr. Johnston, who was early in 1884 specially commissioned by the Royal Society and the British Association to study the interesting fauna and flora of the Kilima-Njaro uplands. During the six months from May to October of that year, passed by him on their southern and eastern slopes, this experienced African traveller has succeeded under great difficulty in collecting abundant materials for illustrating the natural history and physical constitution of the "Mountain of the Snow Fiend," as its euphonious Ki-Swahili name is interpreted. These results are embodied in the work before us, which is alike admirable for its bright and graphic style, and the judicious arrangement of its varied contents. By the simple plan, consistently adhered to throughout, of treating the narrative portion separately, and confining the strictly scientific matter to the concluding chapters, all tastes are consulted, and the common mistake is avoided of sacrificing the interests of the student to those of the general reader.

The few months to which the expedition was limited were passed partly at the station of Kitimbiriu in the Moshi territory ruled over by King Mandara, partly in the more easterly district of Marangu. Both of these tracts are included in the Chaga country, which occupies all the southern slope, which however, as now appears, does not constitute a single kingdom under Mandara, but comprises a considerable number of petty Bantu States, mostly mutually hostile, and seldom combining except to resist the attacks of the common Masai enemy. Mandara, who had hitherto figured in the history of recent East African exploration as a doughty warrior scarcely second in importance to Mirambo himself, thus sinks to the position of a mere triton amongst the minnows, though still powerful enough to be troublesome, and enjoying a somewhat widespread reputation, if not for personal courage, at least for political sagacity.

As shown in the annexed cut (Fig. 1) the aspect of Kilima-Njaro seen from above Moshi is that of a single snow-capped dome towering to a height of nearly 19,000 feet above the bare or grassy upper slopes, and clothed lower down with a dense and varied tropical vegetation. But when viewed from Lake Jipé, a point lying nearer its base towards the south-east, it appears in its true character of a double-crested snowy mass, in this as in some other respects presenting a remarkable resemblance to the Armenian Ararat. Mr. Johnston, who made two ascents, first from Moshi to a height of 9000 feet, and again from Marangu to about the normal snow-line (16,315 feet, or within a little more than 2000 of the summit), calculated the altitudes of the two peaks, Kibô and Kimawenzi, at 18,800 and 16,250 feet respectively. This only slightly exceeds von der Decken's estimate, who assigns 18,700 feet to Kibô, so that the absolute altitude of the probable culminating point of the continent may be taken at somewhat under 19,000. On the lofty connecting ridge clumps of forest were found still straggling up to 10,000 feet. Many bright-coloured flowers also grew up to this altitude, "notably a vivid blue cynoglossum (houndstongue), mauve and blue irises, and pink, waxy-white, and yellow everlastings. Tufts of artemisia (southernwood) grew in sheltered places. There were many heaths, a small kind of geranium, huge proteas, and divers ferns and mosses" (p. 235). Even at 12,600 feet strange sessile thistles were met, nearly five feet in circumference, besides an extraordinary lobelia (*L. Deckeni*) three to four feet in height, and a very characteristic arborescent plant new to science, and since named *Senecio Johnstoni* (Fig. 2), "looking somewhat like a banana in the distance, but in reality consisting of a tall, black, smooth trunk, 20 to 30 feet in height, and surmounted by a huge crown of broad leaves interspersed or headed up with bunches of yellow blossom. The strange composite grew abundantly in the streamlet's bed, and its trunk was so superficially rooted that, in spite of its height and girth, I could pull it down with one hand" (p. 268).

Beyond 13,000 feet vegetation became stunted and patchy, ceasing altogether about the altitude of 15,000 feet. The last resident bird, a kind of stone-chat (*Pinarochroa hypospodia*) was met in flocks, and showing a total absence of fear, up to 13,700 feet, beyond which no bird was seen except a rare high-soaring kite, or great-billed raven. Yet such large game as the elephant, buffalo, and antelope are pursued by the natives up to altitudes of 12,000 and 13,000 feet, and captured chiefly by pitfalls. In the Bura district, east of Kilima-Njaro, the *Alcelaphus cokei*, a species of hartebeest, or tall red antelope, was seen associated by a sort of unconscious symbiosis with tall red ant-hills, and deriving some protection from their almost ludicrous resemblance to these objects. "Being a deep red-brown colour, and standing one by one stock-still at the approach of the caravan, it was really most difficult and puzzling sometimes to know which was antelope and which was ant-hill; for the long grass hiding the animal's legs left merely a red-humped mass, which until it moved, might well be the mound of red earth constructed by the white termites. The unconscious mimicry was rendered the

[1] See the chart quoted in the first note.

[2] "The Kilima-Njaro Expedition, a Record of Scientific Exploration in Eastern Equatorial Africa." By H. H. Johnston, F.Z.S. (London: Kegan Paul, 1886.)

more ludicrously exact sometimes by the sharply-pointed, flag-like leaves of a kind of squill—a liliaceous plant—which frequently crowned the summit of the ant-hill or grew at its base, thus suggesting the horns of an antelope either with the head erect or browsing low down. The assimilation cannot have been fancied on my part, for it deceived even the sharp eyes of my men; and again and again a hartebeest would start into motion at twenty yards' distance and gallop off, while I was patiently stalking an ant-hill, and crawling on my stomach through thorns and aloes, only to find the supposed antelope an irregular mass of red clay" (p. 66).

Amongst the valuable animal specimens secured by our naturalist was one of the new and beautiful species of Colobus (*C. guereza*, Rüpp., var. *caudatus*, var. nov., Fig. 4) first seen and described by Mr. Thomson, which

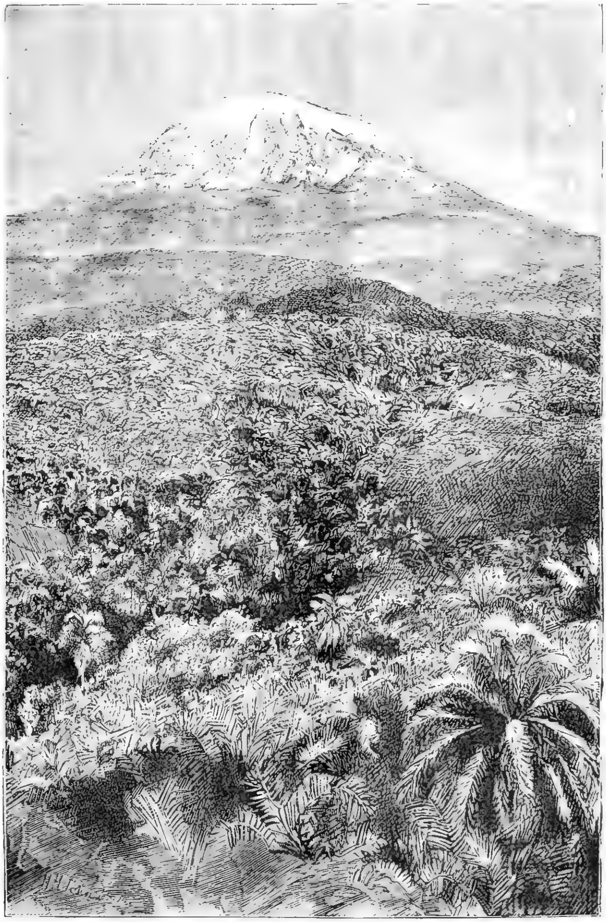


FIG. 1.—Kilima-Njaro seen from above Moshi ("Palms and Snow").

frequents the base of Kilima-Njaro, and is apparently restricted to that region. Mr. Oldfield Thomas, who contributes an important paper on the mammals obtained during the expedition, tells us that it is "characterised by having the white brush of the tail very much larger and finer than is the case in the true Abyssinian *C. guereza*. . . . The hairs of the white body-mantle, entirely cover the black at the base of the tail, the white of the latter and of the mantle being quite continuous" (p. 388).

Besides this paper by Mr. Thomas the work is enriched with several others by specialists, such as Prof. Bonney, who deals with a collection of rocks (mainly igneous) from the higher regions of Kilima-Njaro; Prof. Oliver and Mr. J. G. Baker, to whom botanists will be grateful for a careful enumeration of all the plants collected during the expedition; Mr. F. D. Godman who classifies sixty-one specimens of Lepidoptera, including at least three new species; Charles O. Waterhouse, by whom examples of fifty-six Coleoptera are similarly treated; Captain G. E. Shelley, who jointly with the author gives a descriptive catalogue of fifty species of birds, of which six are new to science, collected or observed in the district; Mr. E. J. Miers, who describes a new variety of river-crab of the genus Thelphusa doubtfully assigned to the species *T. depressa*, Krauss.

But of all the scientific papers by far the most important are the two chapters contributed by Mr. Johnston himself on the anthropology and philolgoy of the Kilima-Njaro district, or rather of all the East Central African region lying between the great lakes and the Indian Ocean. Measured by a pecuniary standard, it is not too much to say that these two monographs alone are fully worth the 1000*l.* granted by the British Association and Royal Society for the purposes of the expedition. Besides a graphic account of the Bantu and Masai peoples, whose respective domains are conterminous, or overlap each other in this part of the continent, we have here a general disquisition on their mutual ethnical and linguistic relations, which fills up at least one great gap in the field of African anthropology. The mystery hitherto surrounding the Masai race is at last largely dissipated, and we are now enabled with some confidence to assign them their true place in the African family. A careful comparative study of their language and physical type clearly shows that their affinities are to be sought amongst the Negro or Negroid peoples of the White Nile, and more particularly the warlike Bari nation of the Gondokoro district. From this basin they appear to have gradually spread in comparatively recent times south-eastwards between the Victoria Nyanza and the coast, encroaching to the east on the Hamitic Gallas, to the south on the Wa-taita, the Wa-chaga, and other outlying branches of the Bantu family. The annexed graphic illustration of a Masai warrior (Fig. 3) betrays some unmistakable Negro features, especially in the short nose, broad nostrils, and thick lips standing wide apart. On the other hand, the close relationship of the Masai and Bari languages is here clearly established, one of the most striking features common to both being true grammatical gender, as indeed had already been pointed out by Lepsius in his Nubian Grammar. Masai must consequently now be separated from the Nuba group, as the Nuba has already been separated from the Fulah of Western Sudan; and thus there is at last an end of Friedrich Müller's "Nuba-Fulah family," which has hitherto figured so largely in treatises on African philology. Its place is taken in East Central Africa by the Bari-Masai group, which Mr. Johnston now proposes to constitute, and which includes, as intervening members, Latuka certainly, Lango, Sûk, and Samburu more doubtfully.

FIG. 2.—*Senecio Johnstoni.*

FIG. 3.—A Masai Warrior.

It will be seen that the rich linguistic data here brought together cannot be neglected by the future student of African philology. The patience and ingenuity expended in the collection of this material is aptly illustrated in the account given of a hunt after a single grammatical element of the Ki-Chaga language current throughout the southern districts of Kilima-Njaro. The object is to determine the exact form of the eighth pronominal prefix (a plural one), of which fifteen altogether are represented in this member of the Bantu family. But "unfortunately I cannot ask any of my friends, 'What is your eighth prefix?' I should never be understood if I explained for a hundred years. I have to get at it in some other way. 'What is this?' I ask, holding up a knife. 'Ki-osho,' they reply. 'Just so,' I replied; 'ki' is the seventh prefix, and the plural must give the form of the eighth. 'How do you say many knives,' I continue; 'ki-osho is *one*; what is many?' 'Shingi' (many), they reply. 'No, but many knives?' 'Shingi' is again repeated. Then I ask, 'See, this is one knife—*ki-osho kimo* (holding up one finger). What is for *two* knives?' (holding up two fingers). 'Two fingers,' they reply, looking up very much puzzled. Then in despair I send for another knife, and placing it beside the original one, again ply them with a question. This only elicits the word for 'another'; but at length after many disappointments they are induced to say *shi-osho shivi* (*two knives*), which gives me *shi-osho* as the plural of *ki-osho*, and consequently *shi* is the form of the eighth prefix, and so on" (p. 162). Of course all travellers amongst the lower races are familiar with difficulties of this sort. But it is not every traveller who during the off hours of a six months' expedition contrives to collect sufficient linguistic materials to reconstitute the philology of a continent.

Mr. Johnston, who is also an accomplished artist, has added much to the value of his work by the numerous illustrations with which he has enriched this handsome volume. His skill especially in portraying animal and

FIG. 4.—*Colobus guereza*, var. *caudatus*.

vegetable forms is sufficiently attested by the specimens here adduced. He also supplies a copious index, as well as carefully prepared route and linguistic charts, besides a large map brought well up to date of Eastern Equatorial Africa between the parallels of 1° N. and 6° S. It remains to be stated that in this notice the somewhat unfamiliar orthographic system of Lepsius, adopted by the author, has been replaced by the usual and sufficiently accurate method adhered to by Stanley, Thomson, and most other English travellers in Central Africa. To the writer it seems that the plan of combining the English consonantal with the Italian vocalic system adapts itself fairly well to the transliteration of most African (Negro) and especially of the Bantu languages.

A. H. KEANE

NOTES

LORD ROSEBERY has endowed a new lectureship in the University of Edinburgh. The course, which will extend over five years, will consist of thirty lectures on the Philosophy of Natural History. The lectureship has been offered to, and accepted by, Mr. G. J. Romanes, M.A., LL.D., F.R.S. This is the second lectureship which has recently been founded in connection with the Chair of Natural History. The other one is on Comparative Embryology, and is occupied by Mr. G. Brook, F.L.S.

AN important discovery has been made by Dr. O. Tumlirz, of Prague. Hitherto no substance amongst those which exhibit diamagnetic properties has been observed to possess any permanent diamagnetic polarity analogous to the permanent paramagnetic polarity of hard steel. The property of retention of diamagnetisation is, however, found to be possessed by rock crystal. Both those specimens which show right-handed and left-handed optical properties are alike in this respect, and the axis of diamagnetisation appears to be independent of the crystallographic axis, and dependent only on the axis of initial magnetisation. Dr. Tumlirz, whose investigation is published in *Wiedemann's Annalen*, appears to think that these facts negative Becquerel's theory of diamagnetism.

We regret to announce the death of Dr. Oskar Schmidt, the eminent Professor of Zoology at Strasburg University; he died on the 17th ult. Also of Dr. Nikolaus Friedrich von Tschudi, the well-known author of the "Thierleben der Alpenwelt." He died at Melonenhof, near St. Gallen, aged sixty-five years.

M. Faye has been appointed President of the Bureau des Longitudes for 1886.

Dr. W. H. Stone will deliver the Lumleian Lectures this year on April 8, 13, and 15, the subject being "The Electrical Conditions of the Human Body."

Two young persons, natives of the central part of Paraguay, are being exhibited at the Westminster Aquarium possessing an abnormal development of hair on the body, a condition to which the term hypertrichosis is applied. One of these is a girl of about eighteen years of age; the other, her brother, aged six years. In the former the whole of the back is covered with hair about one centimetre in length, which extends in the region of the waist to the anterior surface of the body. In addition to this continuous tract of hair there are numerous small patches of varying size distributed irregularly over the face, trunk, and extremities. In the boy the hair tract on the back begins immediately below the level of the lower angles of the scapulæ and extends downwards on the body and extremities almost to the bend of the knees. There are likewise on the body several patches covered with hair, the largest of which is about the size of the palm of the hand, and situated on the front of the thigh; the other patches vary in size from about one to two centimetres in diameter. Contrary to what might have been expected, there is no development of hair in the mesial line of the body in front, or on the cheeks, chin, or upper lip, as is sometimes seen in such cases. In both cases the skin is deeply pigmented, of a dark brown hue wherever the abnormal hair is developed, and on the back of the girl and outer side of the thigh of the boy there is a large and partially filled cist present immediately below the skin. The cist on the boy's thigh seems to be entirely unconnected with the bursa over the trochanter of the femur with which it might be imagined it had some connection. In the family history there is nothing to account for the occurrence of the abnormal condition presented by these two members of the family. The parents are in all respects reported to be normal, as are the other members of their family, which consists of four children in all. In no other respect do the two abnormal members of the family present any peculiarity, such, for example, as in the growth of the teeth, which is not unfrequently found to accompany extra development of hair. Cases of this kind occasionally occur in different parts of the world. The hairy family from Burmah has been the subject of several notices some years ago, and more recently a child from the same country was exhibited at the Aquarium. Several other cases have been recorded, however, occurring in Russia and different parts of America, and other places. The hair sometimes occurs universally spread over the body, when the term *hypertrichosis universalis* is applied to it, or in patches more or less extensive, *hypertrichosis partialis*, as in the present instances.

One of the most appreciated organs of French anthropology, the *Revue d'Anthropologie* of Paris, founded in 1872 by Paul Broca, and continued since the death of that distinguished *savant* by Dr. Paul Topinard, inaugurates the third series this year with the co-operation of the most distinguished representatives of the various branches of anthropological science. Amongst these we notice the names of Dr. Gevarret, Director of the École d'Anthropologie; Dr. Mathias Duval, Director of the Laboratoire d'Anthropologie de l'École des Hautes Études; the Marquis de Nadaillac, whose works on prehistoric archæology have been translated into several languages; Gen. Faidherbe, Great Chancellor of the Légion d'Honneur, and well-known for his philological works; Prof. de Quatrefages; Dr. Hamy and Louis Rousselet, who highly represent ethnography; Baron Larrey; Jules Rochard, of the Medical Service of the French Navy; D'Arbois de Jubainville, of the Institute; and several others. The editorship of the *Revue* will be retained by Dr. Paul Topinard, the General Secretary of the Anthropological Society of Paris, and author of the "Éléments d'Anthropologie," a work to which we recently called the attention of our readers, and for which we are glad to learn the author has been awarded one of the annual prizes of the Académie des Sciences.

The first Report upon the Fauna of Liverpool Bay and the Neighbouring Seas, written by the members of the Liverpool Marine Biology Committee, and edited by Prof. W. A. Herdman, D.Sc., will be published during the present month, in the form of an octavo volume of about 300 pages, illustrated by six plates and a map.

An exploring expedition was to start from Tiflis on the 2nd inst., with the object of thoroughly investigating the natural history of Khorassan. It will be under the direction of Dr. Radde, who will take charge of the botanical department and of the zoology of the higher animals. Dr. Walter, who was lately assistant to Prof. Haeckel at Jena, will have charge of the lower animals. M. Kontjin will be the geologist, and two general assistants will complete the scientific portion of the expedition. It is hoped that their work will be finished by the end of August. A number of specialists will be charged with the task of examining and describing the collections with a view to publication; and it has been already arranged that Dr. Boettger, of Frankfort, will deal with the mollusca, M. Strauch, of St. Petersburg, with the reptiles and amphibia, and Dr. Radde with the birds. It is understood that the Emperor has expressed a strong personal interest in the expedition.

The Parisian authorities systematically liquefy the snow with salt, except on macadamised streets (where the process causes disaggregation of the stones). This practice has obtained since 1881. Rock-salt is used, costing in Paris about 31 francs a ton. Large quantities are stored in the beginning of winter at different places, and when a snowfall occurs a number of workmen repair to these, and each fills a barrow, and takes it to sprinkle on that part of the streets assigned to him. The salt produces its full effect only when the passage of vehicles has mixed it sufficiently with the snow. In two or three hours liquefaction is so far advanced as to allow of the streets being swept. The salt is little used on pavements. Paris spent about 220,000 francs on the fall of snow of December 8 to 10 last; the thickness of the layer varied from 2½ to 4 inches. The quantity of salt used was about 125 grammes on an average per square metre; the cost of it was only about an eighth of the total expense (sweeping cost 3 to 4 centimes per square metre). The employment of salt in the way indicated is found to effect a considerable economy on previous methods.

Some experiments on a large butcher's dog, with reference to the effects of sundry beverages on digestion, have been recently described by Signor Ogata (*Archiv für Hygiene*). The observations were made by means of a stomachal fistula (quite healed); the dog was fed on horse-flesh and fibrin from ox blood. The following conclusions (which may not be strictly applicable to man, accustomed to the drinks named) were reached:—(1) Water, water containing carbonic acid, tea and coffee in moderate amount, do not disturb digestion. (2) Beer, wine, and brandy retard digestion considerably at first, till absorbed; and in the case of beer, the extractive matters act thus as well as the alcohol. Thus beer retards digestion more than wine containing the same quantity of alcohol. (3) Sugar (cane and grape) retards digestion considerably. (4) Common salt accelerates it distinctly.

WE have received the report of the administration of the Museum of Science and Art at Dresden for the years 1882 and 1883, which has only just been issued. It contains nothing calling for especial note. The various scientific collections in the anthropological, zoological, prehistoric, and geological departments were largely increased during the two years by purchase, and specially by donations from private individuals, mainly travellers, or Germans residing abroad.

ON the afternoon of the 29th ult. a strong shock of earthquake was felt at Velez Malaga, which suffered so severely in the earthquakes of December 1884. The town is reported to have suffered little damage, although no precise details have yet been received.

ON January 29 earthquakes were again noticed at M'sila, Bordj ben Arendj, and Setif, Algeria, the site of previous commotions, but no accidents are reported, although the shocks are said to have been strong.

DR. F. J. HICKS writes from Madeira, on January 28, that in the previous week a sharp little shock of earthquake occurred on the island.

A TELEGRAM from Mexico states that the Colima volcano continues in active eruption.

THE last, or December, number of the *Journal* of the Royal Microscopical Society has a new feature, in the form of portraits of a number of past presidents of the Society; Sir Richard Owen, the first president of the Microscopic (1840-41), and Mr. James Glaisher, the first president of the Royal Microscopical Society (1865-66, 1867-68), have full-page illustrations; the two other plates contain eight vignettes each; on one (1842-57) we have, among others, Dr. Fane, Mr. Busk, and the lately deceased Dr. Carpenter, and on the other Mr. J. B. Reade, Mr. Quekett, and Mr. Sorby. Many, if not indeed all, of the photographs are excellent likenesses. We understand that it is the intention of the Society to publish other similar photographs from time to time.

THE so-called wines sent to the Parisian market of late years have been to a large extent, it is well known, vile concoctions, not deserving the name of wine, and a movement is now on foot for replacing such false wine by true cider. The year 1885 has been exceptionally favourable for such an experiment; the crop of apples was so abundant in Normandy and Brittany that growers were obliged to dispose of their products at low prices. Enormous quantities have been sent to Paris to be transformed into cider. It is to be hoped that this new development may check the great falsification of wine.

ON January 21 the exhibition of ethnological and natural history objects collected by Dr. Otto Finch, in his travels undertaken at the request of the New Guinea Society, was opened at the Berlin Ethnographical Museum. Dr. Finch himself gave the necessary explanations to the assembly. The objects were all collected in parts never before visited by Europeans. The collection contains numerous face-casts of the various New Guinea tribes and those of the adjacent island, as well as a large number of water-colour drawings of scenes in the new German colonies.

"H. I. M." writes to the *Times* under date Bratton Fleming, Barnstaple, January 28:—"As I was driving near Barnstaple yesterday evening with a friend, we noticed a most remarkable meteor. While we were ascending a hillside, we suddenly became aware of a brilliant light to our side and rather behind us, from over the hill-top. I thought for the moment that it was a flash of lightning, but on looking up we caught a glimpse of the most beautiful meteor I had ever seen. It seemed to be quite close, and described a path like that taken by a stone in falling when flung horizontally from a tower. It appeared (at its distance) to have a diameter of about 6 inches, and was accompanied by a tail of a smoky consistency, rather of the shape of an elongated open fan with the ends rounded, which followed it, altering its position from a horizontal to a vertical one as the body fell. This tail was, I should say, one and a half times as long as the meteor's diameter, and was of a much paler hue and less dense consistency than the meteor, which was of a most glorious yet rather pale emerald green, with a yellow flame, as it seemed, playing all over it; the tail was of the same tint, only in a less intense degree. It may be of interest to any who may have seen it, that the time we saw it was 27 minutes past 7 o'clock."

ELABORATE preparations are being made at the fishery of the National Fish-Culture Association at Delaford Park for receiving the fry which are now rapidly becoming incubated at the hatchery in South Kensington, special habitats being constructed for them. The whitefish ova that arrived from America last week commenced to hatch out immediately they were placed in the apparatus; indeed, many came to life during the voyage. Unlike other fry, they never rest, but move rapidly hither and thither, their powers of locomotion being marvellous considering their present alevin stage. Further consignments of eggs are on their way from the American Government, who are doing their utmost to aid fish-culture in this country. The fish reared at the Delaford Fishery last year will shortly be ready for distribution. The stock is extensive and valuable, including *S. sebago*, *S. fontinalis*, *S. ferox*, *S. fario*, *S. trutta*, and *S. iridens*.

A CLOSER investigation of the fish-fauna of Lake Balkhash permits M. Nikolsky to arrive at the following interesting conclusions (*Memoirs* of St. Petersburg Soc. of Natur., xvi. 1). The fauna numbers fourteen species, partly described by the late Prof. Kessler (*Perca schrenckii*, *Phoxinus lævis*, var. *balchaschana*, *P. poljakowi*, *Barbus platyrostris*, *Schizothorax argentatus* and *orientalis*, *Diptychus dybowskii*, *Diplophysa strauchii*, *labiata*, and *kungessana*), and three more *Schizothorax*, of which one new one has been described by M. Nikolsky as *S. kolpakowskii*. Of these fourteen species, only one is not new, and none of them has been found either in the Aral-Caspian basin or in the system of the Obi; on the contrary, the fish-fauna of Lake Balkhash is closely akin to that of the lakes of high Central Asia. In both, the Cyprinidæ and Cobitidæ are predominating: four genera of the former are found exclusively in Lake Balkhash and the Central Asian lakes, as also the species of *Diplophysa*. More than that, the *Schizothorax tarimi*, the *S. aksæensis*, and the *Diplophysa strauchii*, which were found by M. Nikolsky in the Ili River, are common to both the Balkhash and the Lob-nor. Only three species distinguish the Balkhash fauna from that of the Central Asian lakes, and make it approach that of the Obi: the *Perca schrenckii*, which, however, differs more from the European and Siberian species than this last differs from the American *P. flavescens* (which, in fact, might be considered as a mere variety), and the *Phoxinus poljakowi*, which is nearly akin to the *Ph. lævis* of the Obi and North-East Europe. From these facts M. Nikolsky concludes that if a direct communication between Lake Balkash and Lake Aral has ever existed—that is, if a marine basin ever covered once the three depressions of the Alatau, the Aral-Caspian, and Siberian—the former was separated from the two latter at a much earlier period than the time when, at least, a fluviatile connection between the Aral-Caspian and the Siberian Ocean had ceased to exist. The separation must have taken place earlier than the separation of the two continents of Asia and America. If a connection existed between the Balkhash and the Irtish during the Post-Tertiary period, it could be only by means of shallow streams where the *Phoxini* could live. On the contrary, the Balkhash and the Lob-nor remained connected after the above separation took place. The connection was carried on through Kunges, the Yuldus, and Tarim. The limits of this basin can be easily determined.

MESSRS. SWAN SONNENSCHEIN AND CO. will publish in a few days a "Tourist's Guide to the Flora of the Alps," translated from the German of Prof. Dalla-Torre, and issued under the auspices of the German and Austrian Alpine Club of Vienna. The volume will appear in the form of a handy pocket-book.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius* ♂) from South Africa, a Malbrouck Monkey (*Cercopithecus cynosurus* ♀) from West Africa, presented by Lieut.-Gen. G. W. A. Higginson, C.B.; a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mrs. J. J. Buchanan; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. H. M. Sharratt; a Common Badger (*Meles taxus* ♂), British, presented by the Hon. Walter de Rothschild; four Moorhens (*Gallinula chloropus*), British, presented by Mr. T. E. Gunn; three Gold Pheasants (*Thaumalea picta* ♂ ♂ ♂) from China, presented by Mr. A. Heywood, F.Z.S.; a Hygian Snake (*Elaps hygiæ*), a Hoary Snake (*Coronella cana*), a Crossed Snake (*Psammophis crucifer*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Great Cyclodus (*Cyclodus gigas*), two Stump-tailed Lizards (*Trachydosaurus rugosus*) a Diamond Snake (*Morelia spilotes*) from Australia, received in exchange.

OUR ASTRONOMICAL COLUMN

PHOTOGRAPHIC EVIDENCE AS TO THE CONSTITUTION OF SUNSPOTS.—M. Janssen, remarking on some exquisite photographs of sunspots which he has obtained during the past year, calls attention to the evidence they supply as to the continuation of the granulation of the general solar surface into the spots. A photograph of the great spot of 1885, June 22, for example, to which he particularly alludes, shows that the bright region which surrounds the penumbræ of large spots has not a different constitution from that of the photosphere in general, since it is made up in like manner of granular elements, usually of a spherical form. The marked increase in brightness of such regions the photographs show to be due to the granulations being more thickly clustered, brighter in themselves, and arranged on a brighter background. In the penumbra the granulations are still distinguishable, but they are less luminous and more scattered, leaving dark gaps between the rows of grains, the familiar striated appearance of the penumbra being due to the arrangement of the granulations in ranks and lines, like beads on a thread. The grains become in general smaller and duller near the nucleus, where they seem to dissolve. The same spot presented two very remarkable bridges, and a very bright isolated mass of luminous matter which united them. This luminous matter and the bridges were also formed of granular elements resembling the others. Many other photographs have revealed a similar structure in penumbræ and their surroundings, so that it is highly probable that "the luminous matter which forms the solar surface has everywhere the same constitution."

THE STRUCTURE OF THE SOLAR ENVELOPE.—A somewhat lengthy paper by M. Trouvelot, on the above subject, originally published in the *Bulletin Astronomique* for June, August, and September last, has recently appeared. The first part of the paper consists of a *résumé* of a number of striking and typical observations which are illustrated in the plate which accompanies it. These observations principally relate to spots of irregular and complicated form; the most remarkable being those in which M. Trouvelot describes the formation of numbers of bright white points over sunspots, like "a fall of snow," sometimes even obliterating them, the formation of purple vapours in connection with both spots and prominences, and the apparent changes and sometimes complete concealment of spots occasionally produced by faculæ. The essentially granular appearance of the sun, so well brought out in M. Janssen's photographs, has by no means escaped M. Trouvelot's notice, and he has even seen the lines C D_1 D_2 b_1 b_2 b_3 and F as themselves granulated, *i.e.* not uniformly dark, but composed of a great number of whitish points separated by dark intervals. The latter part of the paper is occupied with inferences as to the constitution of the solar envelope resulting from a consideration of these observations. The theory formed resembles in its essential characteristics that so admirably set forth by Prof. Young in his book on the sun. The sun is surrounded by a shell relatively very shallow, made up of innumerable vertical filaments due to the condensation of metallic vapours, and which M. Trouvelot proposes to call the *nematosphere*, in distinction to the photosphere, the glowing summits of these filaments. The behaviour of these filaments under various circumstances is discussed, and the varying effects upon them of hydrogen and metallic eruptions from the solar nucleus below of different degrees of violence is made to account for the varied phenomena of spots, faculæ, and prominences. The brilliance of the photosphere is regarded as due to the high radiating powers of these metallic vapours, when on arriving at the surface of the sun they are condensed, partly from the effect of exposure to the cold of space, and partly from expansion, the granulations being glowing clouds composed of these condensed metallic vapours, the summits of these filaments or columns.

M. Trouvelot expressly contradicts the frequently-made assertion that the bright D_3 line of the chromosphere has no counterpart amongst the dark lines of the spectrum of the disk; the line is indeed an exceedingly fine one, but it is unmistakably present.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 FEBRUARY 7-13

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 7

Sun rises, 7h. 30m.; souths, 12h. 14m. 22·8s.; sets, 16h. 58m.; decl. on meridian, 15° 14′ S.: Sidereal Time at Sunset, 2h. 9m.

Moon (at First Quarter on Feb. 12) rises, 8h. 47m.; souths, 14h. 39m.; sets, 20h. 41m.; decl. on meridian, 2° 12′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	7 14	11 26	15 38	20 30 S.
Venus	7 20	13 11	19 2	2 42 S.
Mars	20 4*	2 37	9 10	5 51 N.
Jupiter	21 14*	3 14	9 14	0 50 S.
Saturn	12 46	20 57	5 8*	22 41 N.

The planet Venus is now very near to inferior conjunction.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon

Feb.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
10	B.A.C. 741	6½	18 6	19 12	157 286
12	48 Tauri	6	20 40	21 40	93 347
12	γ Tauri	4	22 45	23 47	128 323
13	71 Tauri	6	1 43	2 25	95 345

Phenomena of Jupiter's Satellites

Feb.	h. m.		Feb.	h. m.	
7 ...	0 0	I. ecl. disap.	10 ...	2 17	III. ecl. disap.
7 ...	0 38	II. tr. egr.	10 ...	5 11	III. ecl. reap.
7 ...	3 8	I. occ. reap.	10 ...	5 40	III. occ. disap.
7 ...	22 3	I. tr. ing.	12 ...	3 43	II. ecl. disap.
8 ...	0 18	I. tr. egr.	13 ...	5 23	I. tr. ing.
8 ...	21 34	I. occ. reap.	13 ...	22 3	III. tr. egr.

The Occultations of Stars and Pheromena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, February 7. Outer major axis of outer ring = 45″·0; outer minor axis of outer ring = 20″·1; southern surface visible.

Feb.	h.	
7 ...	6 ...	Mars at greatest distance from the Sun.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2 ...	81 16 N. ...	Feb. 11,	22 19	*m*
Algol	3 0·8 ...	40 31 N. ...	,, 8,	21 42	*m*
			,, 11,	18 31	*m*
λ Tauri	3 54·4 ...	12 10 N. ...	,, 10,	23 51	*m*
W Virginis	13 20·2 ...	2 47 S. ...	,, 8,	0 0	*M*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 11,	23 54	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 13,	3 5	*m*
S Serpentis	15 16·3 ...	14 43 N. ...	,, 8,		*M*
U Ophiuchi	17 10·8 ...	1 20 N. ...	,, 8,	14 0	*m*
		and at intervals of		20 8	
β Lyræ	18 45·9 ...	33 14 N. ...	Feb. 11,	9 30	*M*
R Lyræ	18 51·6 ...	43 48 N. ...	,, 10,		*m*
δ Cephei	22 24·9 ...	57 50 N. ...	,, 7,	21 30	*m*
			,, 13,	7 0	*m*

M signifies maximum; *m* minimum.

Meteors

There are no important periodical showers at this season of the year. The following are amongst the principal radiants from which meteors may be expected:—Near Capella, R.A. 75°, Decl. 44° N.; three radiants in Ursa Major, R.A. 131°, Decl. 52° N., R.A. 180°, Decl. 56° N., and R.A. 210°, Decl. 53° N.; one from Corona Borealis, R.A. 226°, Decl. 30°; near β Herculis, R.A. 260°, Decl. 0°. February 10 is a fireball date.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
72 Schjellerup ...	6 3 49 ...	26 2·1 N. ...	IV.
η Geminorum ...	6 8 0 ...	22 32·4 N. ...	III.
μ Geminorum ...	6 16 3 ...	22 37·5 N. ...	III.
78 Schjellerup ...	6 28 42 ...	38 32·2 N. ...	IV.
LL 13412	6 49 12 ...	23 46·8 S. ...	Bright lines
51 Geminorum ...	7 6 49 ...	16 21·2 N. ...	III.
115 Schjellerup ...	8 48 57 ...	17 39·9 N. ...	IV.
120 Schjellerup ...	9 3 46 ...	31 25·7 N. ..	III.
R Leo Minor ...	9 38 45 ...	35 2·1 N. ...	III.
R Leonis	9 41 26 ...	11 57·5 N. ...	III.

BIOLOGICAL NOTES

METAMORPHOSIS IN NEMATODES.—Dr. von Linstow sums up our present knowledge as follows:—The Nematelminthes, according to the medium in which the individual developmental stage is passed, present a truly wonderful series of metamorphoses, and no less than fourteen distinct developmental stages may be enumerated. (1) The embryo passes into an adult form direct (without the intervention of a larval stage) in the one medium, and also passes its existence in fresh, salt, or brackish water, in plants, in the earth, or in decaying substances (Dorylaimus, Enoplus, Plectus, Monhystera, Rhabditis, and many other genera). (2) The larvæ live in the earth, the adult form in plants (*Tylenchus tritici, T. putrefaciens, Heterodera schachtii*). (3) The larvæ live in worms, and on their death and decay pass into the earth, when they assume an adult form (*Rhabditis pellio*). (4) The Helminth lives bisexual in the earth, the fruitful females enter the bodies of bees, and produce therein offspring (*Sphærularia bombi*). (5) The larvæ live in the earth, assuming the adult condition in some animal (Dochmius, Strongylus). (6) The Helminth lives as an hermaphrodite form in some animal, the offspring develop into bisexual forms in the earth (Rhabdonema, Angiostomum). (7) Some adult forms differentiate free-living forms developing sexually, and also hermaphrodite forms living parasitically in animals (snails, *Leptodera appendiculata*). (8) The larvæ hatch out in the earth, and then enter some animal, in which they become metamorphosed into hermaphrodite forms (Trichocephalus, Oxyuris). (9) The larvæ live in insects, the adult form in earth or water (Mermis). (10) The larvæ live encapsuled in some animal, and with it pass into the digestive system of some other animal form, in which latter they become adult (Ascaris, Filaria, Cucullanius). (11) For a short time the hermaphrodite form lives in the intestine of some animal, and produces here its larval form, which, penetrating the intestinal walls, makes its way into the muscles, where it becomes encapsuled (*Trichina spiralis*). (12) The adult form lives in the tracheæ of birds; the females lay eggs, which contain well-formed embryos, which get expectorated, to once again enter the bird's system with its ordinary nourishment. In the crop and œsophagus of the bird the embryo hatches out, wandering into the bronchiæ and air-sacs, from whence the larger larvæ find their way to the tracheæ (*Syngamus trachealis*). (13) There will be two larval forms, of which the one will be found in Mollusca, and the other in aquatic beetles and water-boatmen, while the adult form lives in water (*Gordius aquaticus*). (14) There will be two larval forms, of which the one will be found in water, the other in the lung of some Amphibian, from whence it will wander into the intestine of the same animal, where it will develop into an hermaphrodite form (*Nematoxys longicauda*); this latter form is described and figured.—(*Zeitschrift für wissenschaftliche Zoologie*, November 24, 1885, Band xlii. Heft 4, p. 715, pl. 28.)

ARTIFICIAL PROPAGATION OF OYSTERS.—Mr. W. K. Brooks calls attention in detail to a very important fact in the artificial propagation of oysters to which his notice was first called by Mr. W. Armstrong, of Hampton, Virginia. It would appear that "seed" oysters which Mr. Armstrong had placed on "floating-cars" in the mouth of Hampton Creek not only grew more rapidly, but were of a better shape, and therefore more marketable, than those from seed deposited at the same time in the usual way on the bottom. Immediately after the embryo oyster acquires its locomotor cilia there is a period of several hours, when it swims at the surface, and this is the period when it is swept into contact with collectors. As soon as the shell appears, the larva is dragged down by its weight, and settles at the bottom. The greatest danger to which it is now exposed is that it may not at this stage of its existence find a hard, clean surface for attachment. Being of microscopical dimensions, it may be smothered by a deposit of sediment or mud so light as to be invisible, and most of the failures to get a good "set of spat" are due to the formation of a coat of sediment upon the collectors *before* the young oysters come into contact with them. This danger seems to be entirely avoided by the use of floating collectors, for little sediment can fall on a body which is close to the surface of the water, and most of what may fall will be swept off by the currents which bring the swimming embryo oysters into the collectors. The collector employed by Mr. W. K. Brooks was formed by connecting two old ship-masts together by string pieces, with a bottom of coarse galvanised iron netting which had buoyancy enough to support a large quantity of submerged shells. Such floats should be open at the ends to permit free circulation, and should be so moored as to sway with the current. Mr. Brooks moored a collector, on July 4, in front of the Zoological Laboratory at Beaufort, N.C. Although all the oysters in the vicinity, from being in very shallow water, were nearly through their spawning season, and the conditions were anything but favourable, yet there was immediately secured a good "set," and the young oysters grew with remarkable rapidity, no doubt on account of the abundant supplies of food and fresh water, which gained ready access to all of them, and the uniform temperature which was secured by the constant change of water. The importance of this suggestion is obvious: this method may be used by planters to collect their own supply of seed—an object of great importance—when the feeding regions are far removed from native beds. Perhaps time will prove that it may be also used for rearing the oyster to a stage making it fit for the market; when, if so, the better shape and firmer shell would give the supply thus raised a superior value. Even in places where there are no oysters near to furnish the supply of eggs, a few spawning-oysters could be placed among the shells in the collector, after the French method, to supply the "set." Though, as Mr. W. K. Brooks says, "Engagement in business projects is no part of the [direct] office of a University," still, we venture to hold that all advance in scientific knowledge has a bearing on the "business" life of a country, and we believe that these hints, based on the practical experience acquired at the Chesapeake Zoological Laboratory, will not be without value as showing what the man of science may do for the man of business.—(*Johns Hopkins University Circulars*, vol. v., No. 43, p. 10, Baltimore, October 1885.)

REPORT OF THE SUPERINTENDENT OF THE U.S. NAVAL OBSERVATORY[1]

We make the following extracts from this important Report:—

Rear-Admiral S. R. Franklin, U.S.N., continued in the duties of Superintendent until March 31 of the current year, when he was detached therefrom in order to assume command of the United States naval force on the European station. In the interim from that date until June 1, 1885, Commander A. D. Brown, U.S.N., acted as Superintendent, when, under the orders of the Department, Commodore Belknap assumed the duties of the office.

The 26-inch Equatorial.—This telescope has continued in charge of Prof. A. Hall, U.S.N., who has been employed in observing the satellites of the large planets and in observation of double stars.

Though in constant use, the instrument, together with its micrometer, driving clock, and other apparatus, remains in good working order, and the dome, forty-three feet in diameter, covering it, is now revolved with great ease by means of the four horse-power gas-engine which was connected with it in the latter part of 1884. The dome is now turned to any position required in a few minutes, and the work of observing is much facilitated. Mr. George Anderson has charge of the engine, and assists Prof. Hall in the management of the dome.

The complete reduction and discussion of the observations made with this instrument have made good progress during the past year. This is due, in a great measure, to the efficient aid rendered by Lieut. W. H. Allen and Ensign J. A. Hoogewerff, U.S.N. These gentlemen have been very diligent in making the necessary computations, and have shown marked aptitude for the work.

The observations of the satellite of Neptune and those of the two outer satellites of Uranus have been discussed, and the masses of these planets deduced. These results have been published in Appendixes I. and II. of the annual volume of the Observatory for the year 1881.

A discussion of all the observations of Iapetus, the outer satellite of Saturn, is now nearly finished, and will be ready for printing in a few weeks. . . .

The Prime Vertical Instrument.—The work of reducing the observations made in 1883-84 by Lieut. C. G. Bowman and Ensign H. Taylor, U.S.N., for the determination of the constant of aberration, has been pursued. A selection was made of twelve stars of varying right ascension and well-determined places, and the results obtained; the reduction of the remaining observations will be proceeded with as rapidly as possible.

In July of last year a communication was received from the President of the International Geodetic Conference, asking the co-operation of this Observatory with the Royal Observatory at Lisbon in the determination of the problem of the change of latitudes, the observations to be taken with the prime vertical instruments of the two Observatories. Communication was opened and correspondence is still in progress with the Director of the Observatory at Lisbon, and preparations have be n made to undertake the work here very soon after it is known that it will be begun at Lisbon. . . .

Photography.—In the programme of work proposed for the current year it was stated that the work of taking sun photographs daily would be inaugurated as soon as practicable. The work of the Transit of Venus Commission has up to this time prevented any regular system being adopted. Such work, if pursued systematically and continuously, would put this institution on a footing in this regard more nearly equal to that of the larger foreign Observatories where a large mass of data has been accumulated for future measurement, computation, and discussion, forming the basis of much information of value to the student of solar physics.

For purposes of co-operation in this scientific work, photographic observations in different parts of the world being supplemental to each other, it is also desirable that this work be begun, and sooner or later it will have to be taken up here in order to keep pace with the requirements of modern astronomical research and observation. It cannot, therefore, be begun too soon.

It is eminently desirable that this Observatory possess a collection of photographs of astronomical subjects, and so be enabled to solicit exchanges from astronomers abroad that are engaged in celestial photography. But we lack the means and equipment for printing and making photographic positives that can properly be used for such purposes of exchange.

Much work is desirable to be done in photographing star clusters, nebulæ, and the spectra of sun-spots, stars, &c., and in the production of star maps by photography. Should a party from this Observatory be sent to observe the total eclipse of 1886, photographs of the phenomenon will have to be taken. The Observatory should at all times be prepared for such an occasion and have a staff drilled in photographic work, and this might be easily accomplished, as the number need not be great, and it could be made up of officers stationed here.

New Observatory.—The Commodore renews the recommendations of his predecessors for the removal, at an early day, of the plant of the Observatory to the new site selected and purchased for such purpose in 1881.

The plans, long since prepared, have received the approval of prominent scientific men of the country, and the work can be begun as soon as the money is forthcoming; and with the funds in hand, it would take fully three years to erect the buildings, transfer the plant, and get everything into good working order.

The National Academy has been requested by the Department to express its opinion officially as to the advisability of proceeding promptly with the erection of the building, and it cannot be doubted that it will express itself affirmatively in the matter.

The disadvantages of the present location have been so often and so forcibly described that the subject is worn almost threadbare.

To the foresight and energy of officers of the Navy is due the inception and development of this institution. It is emphatically the child of the Navy, and the service is much interested in its welfare and in every effort to extend the sphere of its usefulness. From its humble beginning in 1838 it has now grown to be one of the most important astronomical centres in the world, and it is to be hoped that Congress will recognise the good work hitherto done by granting the means to place the institution on a still higher plane than it now occupies.

Board of Visitors.—The Commodore renews the suggestion heretofore made that a Board of Visitors, composed of competent persons, be appointed annually to visit the institution and inquire into its working, with authority to suggest such changes in the methods pursued, or such new lines of investigation, as it might deem proper to recommend.

Solar Eclipse of 1886.—A total eclipse of the sun will occur on August 29, 1886. The line of totality passes over the equatorial portion of the Atlantic Ocean, and reaches the west coast of Africa, near Benguela, in latitude 12° S. This port is easy of access, and as it is the healthy season, there would be no difficulty in sending a party out in a Government vessel. The duration of the totality at this point is four minutes and forty seconds, affording a more than usually good opportunity for photographic and spectroscopic observations. The question as to the propriety of applying for an appropriation to defray the expenses of an observing party has been referred by the Department to the National Academy, and a report may soon be expected.

Miscellaneous.—During the year the names of 1408 visitors have been recorded, and 1137 permits were issued for night visitors, for whose accommodation the small equatorial is set apart. The presence of these visitors is not allowed to interfere with the regular work of the institution, and permits are only issued for one evening in each week, with exceptional instances.

The records kept by the several observers and watchmen show that only about one night in eight is good for observing, while an exceptionally good night for astronomical work cannot be reckoned upon much oftener than once a month.

[1] By G. E. Belknap, Commodore U.S.N., Superintendent United States Naval Observatory. Dated Washington, October 5, 1885

MOLECULAR PHYSICS

At the meeting of the Berlin Physical Society, on Nov. 20 last, Herr Gerstmann spoke on a work recently issued by Prof. W. C. Wittwer, on "The Principles of Molecular Physics and Mathematical Chemistry." The main problem to which the work addressed itself respected the nature and properties of the imponderable matter, ether, but its arguments were, in the main, drawn from fancy more than from experience. The work was divided into three parts. The first part, the Constitution of Bodies, formulated the theory that the ponderable atoms were not qualitatively, but only quantitatively, distinguished from one another; that the elastic effect of matter on ether, as on ponderable substances, diminished with the distance; and that the density of the ether ranged round ponderable matter did not diminish in proportion to the distance from the mass of atoms, but increased in proportion to the distance. As essential to the constitution of the bodies was further advanced the pressure of ether on the particles of ether ranged round the ponderable atoms. The second part, the Principles of Chemistry, proceeded from the hypothesis that a material particle was capable of attracting only one, or quite few, particles of ether, acting in such a manner, namely, that a fraction of the attractive force, now of the particle of ether, now of the mass particle, was kept in abeyance (conditions which, for reasons otherwise altogether unexplained, were termed "electro-negative" and "electro-positive" respectively), and made use of an accidental property of the curve of the density of elements contained in L. Meyer's "Modern Theory of Chemistry," namely, that in the case of the maxima and minima of this curve, elements related electro-negatively to the neighbouring elements in the curve always passed over to such in which the reverse condition obtained. in order, by calculations described by the author himself as highly uncertain, to determine the molecular magnitude of some elements and the number of particles of ether attracted by their atoms. The third part, the Doctrine of Heat, propounded heat as elastic concussions; in elaborate calculations brought forward for some examples of numbers the argument that the occurrence of the stationary state was explainable under this assumption likewise; and contended against the Mariotte-Gay-Lussac and Avogadro laws, which were incapable of rightly explaining the facts, seeing that these laws and their deduction took no account whatever of the imponderable ether and the pressure of ether.

THE HISTORY OF FOSSIL CROCODILES[1]

IN this communication the author endeavoured to summarise the main facts already known regarding the palæontological history of the Crocodilia, with full references to the principal literature of the subject. After some preliminary remarks upon the structure and distribution of the living members of the order, the leading types of each geological period were successively considered; and the paper concluded by discussing the bearing of these facts upon the evolution of the Crocodilia, as determined by Prof. Huxley in 1875. The earliest crocodilians hitherto discovered are *Belodon*, *Stagonolepis*, and *Parasuchus*, from the Upper Trias—the first-named being met with on the Continent, in India, and in North America; the second, solely known from the yellow sandstones of Elgin; and the third, only recorded as yet from India. The Rhætic Beds and Lower and Middle Lias do not appear to have yielded any remains of this order, but numerous examples have been found in the Upper Lias, and some in a remarkable state of preservation. At present, however, the precise systematic relationships of the Liassic forms have not been very satisfactorily determined, and those from British deposits are especially in need of further study: there are probably two generic types, *Mystriosaurus* and *Pelagosaurus*, and, if the latest researches are to be followed, it would seem that only two species of each are definitely known. In England, according to M. Deslongchamps, two distinct forms, *Mystriosaurus chapmani* and *Pelagosaurus brongniarti*, have been continually described under the name of *Teleosaurus chapmani*. With the Lower Oolites, *Teleosaurus* proper makes its appearance, and ranges at least as far upwards as the Kimmeridge Clay, from which Mr. J. W. Hulke has described a characteristic snout (*T. megarhinus*). *Steneosaurus* is also a Lower Oolite form, ranging to the Oxford Clay; its British representatives are somewhat imperfectly known, though very complete descriptions have been published of well-preserved cranial fossils from French deposits. *Metriorhynchus* is another genus, from the Middle and Upper Oolites, very fully elucidated by M. Deslongchamps in France, but scarcely determined hitherto in English strata. Two forms described by Prof. Phillips under the names of *Steneosaurus palpebrosus* (Kimmeridgian), and *Steneosaurus gracilis* (Portlandian) are truly referable to *Metriorhynchus*, and fragments agreeing specifically with some of the French Metriorhynchs are also recorded. The Upper Oolites also yield the remains of Crocodilia with comparatively short and stout skulls, and very complete specimens have been discovered in the Kimmeridge Clay both of England and the Continent. They belong to the genera *Dakosaurus* and *Machimosaurus*, the former having also been described by Sir Richard Owen under the name of *Plesiosuchus*. Teleosaurians occur rarely in the Wealden and Purbeck Beds—though one or two well-preserved crania of *Macrorhynchus* are known in Germany—and they finally disappear in the Upper Cretaceous series, where they are represented by the scanty remains of *Hyposaurus* and *Enaliosuchus*. Broad-faced crocodilians, adapted for a more terrestrial mode of life than the Teleosaurs, occur somewhat abundantly in the Wealden and Purbeck Beds, and are represented by *Goniopholis*, *Nannosuchus*, *Oweniasuchus*, *Theriosuchus*, and a remarkably interesting genus—*Bernissartia*—recently described by M. Dollo from the now classical deposit of Bernissart in Belgium. The latter, though decidedly Mesosuchian, approaches the living crocodiles and alligators much more closely than any of its congeners, both in the characters of its dermal armour and in certain parts of the skull. The earliest evidence of procœlian crocodiles hitherto made known is from the Cambridge Greensand and the nearly equivalent Gosau Beds of Vienna; Prof. H. G. Seeley has described a few vertebræ, teeth, and fragments of limb-bones, and regards these as referable to at least three specific types. The Upper Cretaceous beds of France and the United States have yielded still more satisfactory remains—including skulls—showing that the Eusuchian sub-order dates back beyond Eocene times; and some of these fossils appear almost indistinguishable from the living genus *Gavialis*. The early Tertiary deposits, both of England and the Continent, are remarkable as affording traces of gavials, crocodiles, and alligators (or alligatoroid genera) associated together, while the three families share no common area of the earth's surface at the present time; the Eocene types, moreover, appear to be rather less differentiated than is the case in the existing fauna. In conclusion, it may be said that the abundant acquisitions of fossil Crocodilia during the last ten years have fully confirmed the views of Prof. Huxley, laid before the Geological Society in 1875; and the Wealden and Purbeck discoveries, particularly, have brought to light facts which were then little more than probable surmises based upon very fragmentary materials.

[1] Abstract of a Paper read at the meeting of the Geologists' Association on December 4, 1885, by Mr. A. Smith Woodward, F.G.S., of the British Museum (Natural History).

PROFESSOR SYLVESTER'S LECTURE "ON THE METHOD OF RECIPROCANTS AS CONTAINING AN EXHAUSTIVE THEORY OF THE SINGULARITIES OF CURVES"

PROFESSOR SYLVESTER sends us the following corrections and additions to his lecture recently given in NATURE (January 7, p. 222):—

Errata

P. 223, 1st column, line 27, for "requirements" read "acquirements."

P. 224, 1st column, line 37, for *geometrical adjustment* read *numerical adjustment.*

P. 225, in the footnote, for $\frac{\eta'''}{\eta}$ read $\frac{\eta'''}{\eta'}$.

P. 226, 2nd column, line 9, p. 227, 1st column, lines 14, 20, 22, 31, 34, 44. and 2nd column, line 16 from bottom, in all thees places for τ read t, and in the last for $\tau - \tau'$ read $t - t'$.

P. 226, 2nd column, line 5,

$$\text{for } \frac{dy}{dx^2}, \frac{dy}{dx^3}, \frac{dy}{dx^4}, \ldots$$

$$\text{read } \frac{d^2y}{dx^2}, \frac{d^3y}{dx^3}, \frac{d^4y}{dx^4}, \ldots$$

P. 226, 2nd column, line 20, for "operation" read "operator."

P. 228, 1st column, line 1, for τ read t.

P. 229, in the 1st line of the footnote in the 1st column, for "generating fraction" read "fractional generating function."

P. 229, the 17th line of the footnote should be

$$\frac{4a^2}{2}\delta_b + 5ab\delta_c + 6\left(ac + \frac{b^2}{2}\right)\delta_d + 7(ad + bc)\delta_e.$$

P. 229, line 21 of footnote, for $\frac{c^2}{2}$ read $\frac{b^2}{2}$.

P. 229, the 22nd line of the footnote should be

$$4a^2\delta_b + 5(ab+ba)\delta_c + 6(ac+b^2+ca)\delta_d + 7(ad+bc+cb+da)\delta_e + \ldots$$

P. 230, for πραγματωυ read πραγματων.

P. 230, 2nd column, line 10 from bottom, for "Buckkeim" read "Buchheim."

P. 231.—The greater circle has been erroneously represented as cutting the ellipse. It should pass outside it, thus—

and its centre should be indicated by an asterisk, as well as that of the smaller circle.

P. 231, Chart 5, and p. 226, the syzygy should be in both places

$$(n-1)^2\left(\frac{d\phi}{dy}\right)^3 a + n(n-1)\left\{\frac{d^2\Phi}{dx^2}\cdot\frac{d^2\Phi}{dy^2} - \left(\frac{d^2\Phi}{dxdy}\right)^2\right\}\Phi = z^2H.$$

P. 231, Chart 2, in the last binariant Protomorph but one, for $+\ 5abe$, read $-\ 5abe$.

Chart 6, last line but one, for $H + \Lambda U$ read $H = \Lambda U$.

For "Boole-Mongian" read "Boolo-Mongian" *passim*.

Those desirous of obtaining systematic information on the subject of the lecture may consult the following recent articles from the pen of its author, viz. one on "Schwarzian Derivatives," followed by another on "Reciprocants" in the *Mathematical Messenger*, four "Sur une nouvelle théorie de formes algébriques," a fifth "Sur les Invariants Différentiels," which have already appeared, and a sixth "Sur les réciprocants purs irréductibles du quatrième ordre," about to appear in the *Comptes rendus* of the Institute.

It may be as well to mention that the papers in the *Messenger* were given in long after the dates which the numbers of the *Messenger* bear on their cover, those dates being by some months anterior to the time of their actual issue. In the absence of this explanation the theory would appear to have been in print long before the time when it is stated to have been discovered.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—Prof. Stirling succeeds Dr. Gamgee as an examiner in the Honour School of Natural Science, not Prof. Burdon-Sanderson, as stated last week.

CAMBRIDGE.—Mr. A. E. Shipley, B.A., Scholar of Christ's College, has been appointed Demonstrator of Comparative Anatomy. Mr. Shipley was placed in the first class in the Natural Sciences Tripos Part II., for Zoology and Comparative Anatomy.

It is recommended by the Council of the Senate that the University should now take over the machinery and other plant of the Engineering School belonging to Prof. Stuart. In 1883 its value was estimated at 2500*l.* It has since been considerably added to. Out of the receipts from students' fees and for payments for work done for University departments and private persons, the machinery has been kept in good repair, 10 per cent. has been set aside each year for depreciation, and 5 per cent. has been paid upon the capital, and in addition a profit of 100*l.* was made last year.

SCIENTIFIC SERIALS

The American Journal of Science, January 1886.—Observations on invisible heat-spectra and the recognition of hitherto unmeasured wave-lengths made at the Alleghany Observatory, by S. P. Langley. It is agreed that all cold bodies must not only radiate heat to still colder bodies, but, according to our present conception of radiant energy, be also capable of giving a spectrum, whether we can recognise it or not. The object of the present paper is to describe the actual formation of such spectra and the recognition of their heat in approximate terms of wave-lengths. From the author's researches it is inferred that some of the heat radiated by the soil has a probable wave-length of over 150,000 of Ångström's scale, or about twenty times the wave-length of the lowest visible line in the solar spectrum as known to Fraunhofer.—Botanical necrology of 1885, by Asa Gray. Obituary notices are here given of Charles Wright, of Wethersfield, Connecticut (1811-1885); George W. Clinton, of Albany, New York (1807-1885); Edmond Boissier, of Geneva (1810-1885); and Johannes August Christian Roeper, of Basle (1801-1885).—The isodynamic surfaces of the compound pendulum, by Francis E. Nipher. It is generally assumed that particles near and below the axis of suspension are retarded, and those near the bottom of the pendulum accelerated, by reason of their connection with the system, while the series of particles forming the axis of oscillation are neither accelerated nor retarded. But although this may be true as regards the time of a complete oscillation, it is shown that in any compound pendulum the particles near the bottom do not exert a constant retarding effect upon the system.—The peridotites of the "Cortlandt Series" on the Hudson River, near Peekskill, New York, by George H. Williams. In his paper the author gives a petrographical description of the most basic members of that most interesting group of massive rocks which occurs on the southern flank of the archæan highlands about forty miles north of the city of New York.—Description of a meteorite from Green County, Tennessee, by Wm. P. Blake. This mass of meteoric iron, which was found by a farmer ploughing his field in 1876, and is now in the writer's collection, weighs 290 pounds, is of the shape of a flattened cigar, 36 inches long, 10 broad, and 6 thick. It clearly belongs to the class of exfoliating deliquescent irons, several examples of which have been found in Tennessee, Georgia, and North Carolina. A quantitative determination of a small slice from one end by Baumhauer's method gave iron 91·421, nickel 7·955.—Tendril movements in *Cucurbita maxima* and *C. Pepo*, by D. P. Penhallow. In his paper, which is not concluded, are contained the results of a study made some years ago on the movements of the squash tendrils and terminal bud. Subsequent discoveries touching the continuity of protoplasm have served to give a clue to certain phenomena observed during the researches, but which at the time could not be satisfactorily accounted for. This clue was followed up during last summer, with the result that the true explanation of the tendril movement in *Cucurbita*, and possibly also in the whole family of *Cucurbitaceæ*, appears to have been reached from histological research.

Bulletin de l'Académie Royale de Belgique, November 1885.—Solution of Wrouski's universal problem, and of another problem relating to the integration of differential equations, by Ch. Lagrange. This is the fifth memoir devoted by the author to the elucidation and correction of Wrouski's writings. Here he demonstrates and generalises for any number of variables, the following theorem: Given a differential equation of any order n:

$$\phi\left(\frac{d^nx}{dt^n}, \frac{d^{n-1}x}{dt^{n-1}}, \ldots \frac{dx}{dt}, x, t, a\right) = 0,$$

between the dependent variable x and the independent variable t (a being a parameter), an equation which may be integrated for $a = 0$, the coefficients of the development of x according to the powers of a are absolutely known functions of t given by simple quadratures.—Researches on the spawning of the toad (*Bufo vulgaris*), and on the protecting layers of the egg in the batrachian family generally, by M. Héron-Royer.—Note on the origin of diastase and on the reduction of the nitrates to nitrites, by M. Ed. Jorissen. The author's experiments tend to confirm the views of Traube and Pfeffer, who regard the physiological character of the Bacteria and of the Mycetæ in general as profoundly different from that both of plants and animals. He further endeavours to show that the reduction of nitrates to nitrites by germinating grains must be attributed to the presence of the Bacteria of putrefaction in the surrounding fluid.—Experimental researches on the influence of magnetism on polarisation in the dielectrics, by Edmond van Aubel. The object of these researches is to ascertain whether it be possible to establish a parallelism between the electro-magnetic rotation of the plane of polarisation of light, the phenomena of the reflection of light on a magnet, and Hall's discovery. But the result so far has been unsatisfactory.—Note on the late Gen. Baeyer's views regarding an annual oscillation in the level of the Baltic Sea, by Gen. Liagre. Even admitting the accuracy of the observations tending to show that in the Baltic the tides rise higher in summer than in winter, the author is disposed to attribute the phenomenon rather to local physical causes than to Baeyer's astronomic theory of solar action.—Note on the geological formation of the Juan Fernandez islands, by A. L. Renard. The prevailing rocks throughout this group would appear to be mainly basaltic, with little or no trace of lavas or other recent eruptive matter.—On some new groups of fossil remains from the Upper Chalk and Lower Eocene Tertiary formations of Belgium, by Ed. Dupont. These specimens, now mounted in the Brussels Museum of Natural History, include fragments of a Dinosaurian (*Orthomerus dolloi*) from the Maestricht district; the head and various bones of the gigantic *Mosasaurus camperi*, from Limbourg and Montague Sainte-Pierre; remains of a new type of Mosasaurian recently described by M. Dollo under the name of *Plioplaticarpus marshi*, from Maestricht; remains of another Mosasaurian from Ciply, new in Europe, but well known in America, which M. Dollo has named *Polygonodon ciplyensis*; the carapaces of two large turtles from Maestricht, *Chelonia hoffmanni*, Gray, and *Ch. suyderbuycki*, Ubags; lastly, the skull of a crocodile affiliated by Dollo to the *Crocodilus affinis* discovered by Marsh in the Eocene of the far west.—Note on the whale captured last May off Fécamp, by P. J. van Beneden. At first supposed to be a *Balænoptera musculus*, L., or else a new species, the author shows that this cetacean is the *Balænoptera rostrata*, Fabricius, a specimen of which was taken in 1878 near Villefranche in the Mediterranean.—A study of François Huet and his philosophic writings, by O. Merten.

SOCIETIES AND ACADEMIES

London

Royal Society, January 7.—"Contributions to the Anatomy of the Central Nervous System of the Plagiostomata." By Alfred Sanders, M.R.C.S., F.L.S. Communicated by Dr. Günther, F.R.S. (Abstract.)

After referring to the literature of the subject, and describing the macroscopic aspect of the brain, and partly the distribution of the cranial nerves, the author proceeds to give an account of the histology of the segments of the brain.

The olfactory lobes are well developed. They present three layers. Internally cells of the smallest category are found; they give off several processes which join a network penetrating the whole layer; through the medium of this network these cells communicate with the glomeruli which form the middle layer. These glomeruli are much better developed than in the Teleostei; here they present a central core of closely intertwined fibrillæ inclosed externally by fibrils of a larger size, in the course of which cells are developed; these are arranged parallel to the long axes of the glomeruli, and join the external layer, which consists of fibres passing from the anterior end of the olfactory lobe to supply the olfactory organ.

In the Rays these lobes are solid, but in the Scyllium, Rhina, and Acanthias they contain a ventricle which communicates through a long peduncle with the ventricles of the cerebrum.

The cerebrum presents externally a layer of neuroglia without cells, or at least with comparatively few; the remainder of the parenchyma presents cells of a medium size which are usually distributed in groups with neuroglia interspersed between them; these groups in Scyllium contain from nine to fifteen cells, in the Rays generally more. Four special groups of cells occur towards the base of the brain, two in the outer and two in the inner walls: from the former arise the anterior commissure, and from the latter the crura cerebri.

Two ventricles occur in the cerebrum of Scyllium, Rhina, and Acanthias which homologise with the lateral ventricles in the cerebrum of Mammalia. At the posterior part they coalesce into one chamber which is in communication with the third ventricle; this chamber is evidently the foramen of Monro. Dr. Wilder is of opinion that the ventricles of the olfactory lobes represent the lateral ventricles, and that their apertures of communication with the above-mentioned chambers homologise with the foramina Monroi. A consideration of the case renders this idea improbable. In the Rays the ventricles are reduced to a very small chamber occupying the posterior end of the cerebrum.

The crura cerebri form two projecting walls of a gutter-shaped passage which communicates with the third ventricle. As Prof. Owen has already pointed out, they probably homologise with the nervous cords which connect the supra- with the infra-œsophageal ganglia in Invertebrata; and it is through the third ventricle that the œsophagus of the probable invertebrate ancestor of the Vertebrata could have reached the present dorsal surface without breaking through nervous tissue; for dorsally the choroid plexus and pineal gland cover in this ventricle, there being no nervous tissue here, and inferiorly it communicates through a chamber in the hypoarium with a chamber in the centre of the pituitary body; the endothelium lining the former being continuous with the endothelium lining of the latter.

The optic lobe which arches over the aqueduct of Sylvius corresponds to the tectum lobi optici of the Teleostei; the structure is much simpler, although comparatively speaking the lobe is larger. Externally it is occupied by the fibres of origin of the optic nerve; within these a transverse commissure is visible homologising with the transverse commissure in the tectum lobi optici of Teleostei. Internally a ganglion of large cells occurs variously arranged in the different species; these cells are of large size, but differ from the cells of the ventral horn of grey matter of the cord in texture, and in the fact of giving off only one process as a rule, which process runs into the above-mentioned transverse commissure. Numerous cells of small size, many of which are fusiform, occur in this lobe; these are more numerous in the centre.

The author's researches do not bear out the statement of Rohon that the thalamencephalon projects backward and covers the mesencephalon in the optic lobe; so that according to this author it is composed of both these segments of the brain. Apart from embryological considerations, which give no countenance to this idea, there is nothing in the structure of this lobe which indicates an origin from two distinct primary vesicles of the brain; on the contrary, its structure is homogeneous.

The cerebellum presents a structure corresponding to that in the Teleostei. There are, counting from within outward, the granular, fibrous, Purkinje cells, and molecular layers. The differences consist in the greater number of processes given off by the Purkinje cells, and in the greater number of small cells found in the molecular layer. Another difference is found in the presence of a ventricle which is largest in Rhina, Acanthias, and Scyllium, and reduced to very small dimensions in the Raja.

The molecular layer is continued down on to the surface of the medulla oblongata from the cerebellum, forming the restiform bodies. In the spinal cord there are distinguishable three columns on each side: a dorsal above the dorsal cornu, a lateral at the side, and a ventral beneath; the latter consists of fibres of a larger calibre than those constituting the other columns, but no gigantic fibres—the so-called Mauthner's fibres—are present, as in the Teleostei.

The deep origins of the cranial nerves. The optic nerve arises as above-mentioned from the outer half or more of the optic lobes, also by a few fibres from the hypoarium. This fact was contradicted by Bellonci in reference to the origin of this nerve in Teleostei, but further researches and consideration compel the author to adhere to his original statement.

The oculomotor arises from a ganglion in the floor of the aqueduct of Sylvius. There is no decussation of the fibres of origin of this nerve as is stated by some authors; the error probably arose from the presence in this region of a decussation of fibres derived from the transverse commissure in the optic lobe: this decussation of fibres corresponds to the commissura ansulata in Teleostei.

The facial arises from a small bundle of fibres which comes forward from the lateral columns of the cord, and is situated at the side of and slightly above the central canal.

The trifacial arises from a tuberosity overhanging the fourth ventricle immediately contiguous to the restiform bodies, also from the grey matter of the floor of that ventricle.

The vagus arises from a series of rounded tubercles which occupy the lateral portions of the floor of the fourth ventricle.

Linnean Society, January 21.—W. Carruthers, F.R.S., Vice-President, in the chair.—Mr. Harry Veitch exhibited, in illustration of Dr. Masters's paper, a series of living conifers, among which were: *Abies Fortunei*, *A. nobilis*, *A. grandis*, and *A. amabilis*; also *Pseudolaryx Kæmpferi*, *Picea Omorika*, *Pinus Pencei*, *Arthrotaxis selaginoides*, and others.—Mr. E. M. Holmes exhibited a specimen of the ergot of Diss (*Arundo tenax*) from Algeria. This ergot is said to be more active medicinally than that of Rye, and is slenderer and twice or thrice its length, and is attributable to the fungus *Claviceps purpurea*.—Dr. C. Cogswell drew attention to dried specimens of the species of maples (*Acer*) of Canada collected by him in Nova Scotia, and of *Sisy-*

rhynchum Bermudianum and *Bryophyllum calycinum* from Bermuda. He contrasted the great difference of climate and vegetation of the continent and island, observing that the Gulf Stream doubtless had an important influence on the Bermudan flora; moreover, it was notable that Bryophyllum, like the maples, put on a brilliant red autumnal tint.—There was exhibited for M. Buysman examples of Rudbeckia and Lupinus prepared as teaching specimens of medicinal plants.—Dr. Maxwell Masters read a paper, contributions to the history of certain conifers. This comprised the result of observations on the mode of growth and structure of various species of Coniferæ, concerning which much difference of opinion had previously existed owing to the imperfection of our knowledge. Of late years many of these species had been introduced into cultivation and some of them had produced male flowers and cones, thus affording an opportunity for diagnosing the species and ascertaining their limitations. The study of the cultivated plants had likewise shown the natural range of variation in a species or individual plant under comparatively uniform conditions. Our knowledge of their geographical distribution has also been extended, altogether thus enabling a fresh revision to be attempted.—Dr. T. Spencer Cobbold read a paper on *Strongylus axei*, and its affinities. This diminutive maw-worm, obtained from the stomach of a donkey, possesses interest, inasmuch as its structural characters closely correspond with those of the entozoon infesting the ostrich's proventriculus. It also shows affinity with the grouse strongyle and with the stomach-worm of lambs; while its peculiarities throw light upon other questions of morphology, especially its relations to the singular maw-worm (Simondsia) of the hog.—In exhibiting an extensive series of fossil plants from the Island of Mull, Mr. J. Starkie Gardner gave remarks concerning inferences to be drawn from the well-preserved leaves. He mentioned that this fossil Mull flora comprises but one fern undistinguishable from living *Onoclea sensibilis* of Western America and Eastern Asia. There is an Equisetum. The Coniferæ are abundant; a *Ginkgo* resembles existing species, along with numerous firs and larches, a few of these latter being similar to those of Japan. Monocotyledons are represented by one having a sword-shaped leaf. There are at least twenty species of dicotyledons. A *Platanus* obtains, differing somewhat from the recent form, and with resemblances to what is known as *Credneria* and *Protophyllum* of Cretaceous age. This Mull flora, though possessing few novelties, is interesting as supplying fresh confirmation of the view first propounded by Asa Gray—that formerly the entire northern temperate regions possessed a very uniform flora.

Anthropological Institute, January 12.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of Mrs. C. Brooke (H.H. the Ranee of Sarawak) was announced.—Mr. Bryce-Wright exhibited a bronze sword, of the leaf pattern, found by the late Capt. Sir William Peel, R.N., at Sandy, Bedfordshire.—A collection of flint implements from the junction of the Thames and Wandle was exhibited by Mr. G. F. Lawrence.—Dr. R. Munro read a paper on the archæological importance of ancient British lake-dwellings and their relation to analogous remains in Europe. The lake-dwellings of Scotland were essentially the product of Celtic genius, and were constructed for defensive purposes. Dr. Munro believes that those in the south-west parts of the country attained their greatest development in post-Roman times, after Roman protection was withdrawn from the provincial inhabitants, and they were left to contend single-handed against the Angles on the east and the Picts and Scots on the north. He suggested the theory that the British Celts were an offshoot of the founders of the Swiss lake-dwellings, who emigrated into Britain when these lacustrine abodes were in full vogue, and so retained a knowledge of the custom long after it had fallen into desuetude in Europe. Amongst other arguments in support of this hypothesis, Dr. Munro pointed out that the geographical distribution of the lake-dwellings in Europe closely corresponds with the area formerly occupied by the Celts, and that they are identical in structure with the crannogs.—In a paper on three stone circles in Cumberland, Mr. A. L. Lewis showed that in these circles, as in others previously described by him, there is a marked preponderance of outlying stones and prominent hills towards the north-east, and that the circle-builders followed the Babylonians rather than the Egyptians in their rules of orientation. In the relation between stone circles and adjacent hills and outlying stones, suggestions might be found not only of sun-worship, but also of mountain-worship and of phallic worship.

Royal Meteorological Society, January 20.—Mr. R. H. Scott, F.R.S., President, in the chair.—The Secretary read the report of the Council, which stated that the past year had been one of great activity, as the eight Committees which had been appointed had met frequently, and had done much for the advancement of meteorology. The number of Fellows on the roll of the Society is 537.—The President in his address said that, as he had treated of land climatology in his previous address, he proposed to deal with marine climatology on the present occasion, and to take up the subject at the point where he had left it in his paper, "Remarks on the Present Condition of Maritime Meteorology," printed in the Society's *Quarterly Journal* for 1876. He enumerated the various investigations which had been announced to be in progress at that date, and specified the several outcomes of these inquiries which had seen the light during the ten years. The "Meteorological Charts for the Ocean District adjacent to the Cape of Good Hope," published by the Meteorological Office in 1882, were first noticed, and the methods of "weighting" observations of wind, &c., employed in that discussion were fully explained, as well as the mode of representation of barometrical results. The "Charts showing the Surface Temperature of the Atlantic, Indian, and Pacific Oceans," published in 1884, and those of barometrical pressure, now in the engraver's hands, were next noticed; and it was announced that the Meteorological Council had decided to undertake the issue of monthly current charts for the entire sea-surface. The wind charts published by the late Lieut. Brault, of the French Navy, were next described, with an expression of the profound regret with which the intelligence of his premature death in August last had been received by all meteorologists. The wind charts and pressure tables issued by the Meteorological Institute of the Netherlands were then explained, and also the publications of the Deutsche Seewarte at Hamburg, "The Atlas of the Atlantic Ocean," &c. The series of "Monthly Charts for the Atlantic and Pacific Oceans" issued by the Hydrographic Office, Washington, were then described, and the present series of "Pilot Charts" issued by the same office were explained. As for projected work in 1886, Mr. Scott stated that the daily maps of Atlantic weather for the year of the circumpolar expeditions were now complete, and were being engraved, a process which must take several months. The German Office had undertaken the preparation of daily weather maps for the same period for the South Atlantic. The Meteorological Office had also taken up the marine meteorology of the Red Sea. The Dutch Institute had announced its intention to publish an atlas for the Indian Ocean. In conclusion Mr. Scott stated that there still existed a lamentable want of data for the Pacific Ocean, but that, thanks to the energy of the Canadian Government in opening up their new Pacific Railroad, it was to be hoped that every year would bring a greater amount of traffic to British ports on the Pacific Coast, and therefore a greater number of observations to the Meteorological Office, while from the existing trade to San Francisco a mass of materials was quickly accumulating for certain routes at least over the vast area of the Pacific.—The following gentlemen were elected the Officers and Council for the ensuing year:—President: William Ellis, F.R.A.S.; Vice-Presidents: George Chatterton, M.Inst.C.E., Edward Mawley, F.R.H.S., George Mathews Whipple, F.R.A.S., Charles Theodore Williams, M.D., F.R.C.P.; Treasurer: Henry Perigal, F.R.A.S.; Trustees: Hon. Francis Albert Rollo Russell, Stephen William Silver, F.R.G.S.; Secretaries: George James Symons, F.R.S.; John William Tripe, M.D.; Foreign Secretary: Robert Henry Scott, F.R.S.; Council: Edmund Douglas Archibald, William Morris Beaufort, F.R.A.S., Arthur Brewin, Frederic William Cory, M.R.C.S., Henry Storks Eaton, Charles Harding, Richard Inwards, F.R.A.S., Baldwin Latham, F.G.S., John Knox Laughton, F.R.G.S., William Marcet, M.D., F.R.S., Cuthbert Edgar Peek, F.R.A.S., Capt. Henry Toynbee, F.R.A.S.

Physical Society, January 23.—Prof. Guthrie, President, in the chair.—The following communications were read:—A note on the paper by Prof. W. Ramsay and Dr. S. Young on some thermodynamical relations, by Prof. W. E. Ayrton and Prof. John Perry. The authors, after referring in the highest terms to the careful experimental work of Messrs. Ramsay and Young in their investigation upon "some thermodynamical relations," the results of which were communicated to the Society at its last meeting, show that the four laws stated in their paper are in reality only one, since if any one of them is assumed the remaining three may be deduced from it. Hence it is sufficient to examine only one, and of the four the third is in the form that can be most readily tested. This law, the statement of which is, that for all substances at any given pressure the product $t\frac{dp}{dt}$ is constant, p being the pressure, and t the absolute temperature of saturated vapour at that pressure, is represented mathematically thus—

$$t\frac{dp}{dt} = \phi(p) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$\phi(p)$ being a function of the pressure, independent of the substance. Writing this equation

$$\frac{dp}{\phi(p)} = \frac{dt}{t}$$

and integrating, we get

$$t = a\psi(p) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$\psi(p)$ being also a function of the pressure only, and a a constant depending only upon the substance employed. It is in this form that the authors have examined the third law; if true, it follows at once from (2) that the ratio of the temperatures of two saturated vapours to one another at any pressure is the same as the ratio at any other pressure. It is seen, however, either by reference to Regnault's numbers, or Rankine's formula—

$$\log p = d - \frac{\beta}{t} - \frac{\gamma}{t^2} - \ . \ . \ .$$

an expression based upon his molecular theory, and which, as remarked by one of the authors at the last meeting, agrees with Regnault's results with remarkable closeness, that this ratio is far from constant. The authors are therefore compelled to conclude that the expressions given by Prof. Ramsay and Dr. Young must not be regarded as absolute laws.—A note on the paper by Prof. J. W. Clarke on the determination of the heat-capacity of a thermometer, by Mr. A. W. Clayden. The author has applied a correction to an expression given by the late Prof. J. W. Clarke for measuring the heat-capacity of a thermometer, in a paper communicated to the Society at a previous meeting (April 25, 1885). Prof. Clarke's expression was affected by the mercury not entirely filling the bulb and stem of the thermometer. The corrected expression obtained by the author is

$$V_1 = \frac{V(s - s_2)}{s_1 - \dfrac{s_2(1 + \beta)}{1 + at}}$$

s, s_1, and s_2 being the mean densities of the instrument, mercury, and glass respectively, β and α the coefficients of voluminal expansion of mercury and glass, V and V_1 the volumes of the instrument and of the mercury.—Note on some organic substances of high refractive power, by Mr. H. G. Madan. In the course of some correspondence respecting M. Bertrand's polarising prisms, the author was informed that the cement used was napthyl-phenyl-ketone dibromide. He has consequently prepared specimens of the ketone, and subjected them to optical examination. The ketone is a thick yellow oil, boiling at a temperature near the boiling-point of mercury; it appears to be a very stable, neutral, and harmless substance like Canada balsam, but unfortunately it does not appear to be capable of hardening, and hence is not by itself adapted for a cement. Its refractive index for the D line is 1·666, higher than that of carbonic sulphide, while its dispersive power is approximately the same as that of that substance. The author has made the bromide of the ketone referred to above, but it seems liable to decompose with formation of hydrobromic acid, which acts upon the spar. Mr. Madan also exhibited a specimen of metacinnamene, a highly refracting glass-like solid obtained by the action of light or heat upon cinnamene. This substance possesses a refractive index of 1·593 for the D line, and would make a valuable cement if it showed a firm adhesiveness for glass.—The President exhibited and described an instrument he had made in the course of an acoustical investigation upon which he had been engaged. It is a musical instrument similar in principle to the harmonicon. In the case of the harmonicon the rectangular plate is usually supported by strings passing through the nodes, but the author wished to make an instrument that could be "bowed." The "nodes" are not absolute positions of rest, the particles at them describing curves having cusps pointing outwards. The plan adopted was to solder two springs to the plate, which was of brass, the points of attachment being slightly outside the nodes, and the springs being such as to give the same fundamental note as the plate. The other ends of the springs were attached to the mouth of a resonator whose fundamental note was also that of the plate. The plate when struck or bowed gave a tone very like that of a tuning-fork, and in a discussion that followed, Prof. S. P. Thompson suggested the possible use of these instruments as a substitute for a series of forks the cost of a complete set of which often places them beyond the reach of the student. Prof. McLeod suggested that the springs should be tuned to the octave of the plate instead of to its fundamental, and that they should have a slightly different form.

Edinburgh

Royal Physical Society, January 20.—Prof. Turner, F.R.S., President, in the chair.—Obituary notice of the late Dr. Carpenter, by Prof. Ewart.—The President read a paper on the occurrence of the bottle-nosed whale (*Hyperoodon rostratus*) in the Scottish seas. After a review of the history of this whale, Prof. Turner proceeded to describe several specimens which had come under his observation, more especially a young male, caught at Dunbar in November 1885. He then compared the external characters of Hyperoodon, Mesoplodon, Ziphius. A detailed description of the rudimentary teeth in the upper and lower jaws of Hyperoodon was also given, and the periods of the year when this animal migrated southwards and northwards were referred to.—Mr. Brook read a paper on the relation of yolk to blastoderm in fish-ova. The author endeavoured to show that the function of the cortical protoplasm surrounding the yolk (the parablast) is primarily a digestive one. The existence of this layer is a necessary consequence of the separation of yolk from protoplasm in meroblastic ova. The material thus elaborated in the parablast is undoubtedly budded off in the form of cells. It has been asserted by Hoffmann and others that these take no part in the formation of the embryo, but are used up in the temporary circulatory system around the vitellus. In the herring, cod, Trachinus, and probably the whole group of pelagic ova, there is, however, no trace of a vitelline circulation, yet cells are produced in the parablast of these forms in the same manner as in the trout. There thus appears no alternative but that the cells must take part in the formation of the embryo. It was therefore argued that, from a consideration of the physiological function of the parablast, the morphological value of this layer is more important than has been hitherto admitted.—A note was communicated from Mr. Dendy, on an abnormal specimen of Comatula (which had twelve arms) from the Firth of Clyde; Mr. Raeburn read extracts from his journal on the birds of the Shetland Islands; and Mr. Muirhead exhibited a specimen of the Glossy Ibis (*Ibis fascinellus*) shot last September on the borders of Roxburghshire, and a Garganey shot last February in Berwickshire.

Dublin

Royal Society, December 16, 1885.—Physical, Experimental, and Applied Science Sections.—Sir Robert W. Jackson, C.B., in the chair.—On the description by points of the principal caustics of a circle, by G. Johnstone Stoney, D.Sc., F.R.S.—Meteors and meteorites, by W. H. S. Monck, M.A.—On the fog-penetrating power of the double quadriform burner, by Prof. W. F. Barrett. The author described the results of some experiments recently made to test the illuminating power of Mr. Wigham's latest adaptation of gas to lighthouse illumination. The double quadriform burner consists of a series of four superposed 88-jet gas-burners placed alongside of four similar superposed burners. The eight burners are in one plane, parallel to which, and at the proper focal distance, are placed eight annular lenses on one side, and a similar set of lenses on the other side. The lights blend into one at a distance of about 1500 feet from the lighthouse. Experiments were made on two evenings, both of which were foggy. On the second evening the fog was so dense that a powerful revolving light less than half the distance of the double quadriform was entirely cut off, and the sound of a large fog-siren, driven by a gas-engine and placed alongside the experimental light, was also extinguished by the fog; nevertheless, on both occasions the double quadriform was easily seen by the naked eye, and its position readily determined, at six miles' distance. The author expressed his unqualified satisfaction at the result of his observation, and hoped that the authorities at Trinity House would be induced to come to Dublin and judge for themselves of the merit of Mr. Wigham's invention.

Section of Natural Science.—V. Ball, M.A., F.R.S., in the chair.—Note on the deposit of supposed worked flint implements at Thenay, near Blois, by Prof. J. P. O'Reilly, C.E.—On the occurrence of a tract of Old Red sandstone and Conglomerate amongst the Knockalla Hills, co. Donegal, by Prof. E. Hull, LL.D., F.R.S.—On a Clogg almanac in the Science and Art Museum, by B. H. Mullen, B.A.—Prof. Haddon exhibited models made by Krantz, illustrating the evolution of the shells of fossil Cephalopoda.—Mr. Greenwood Pain exhibited a remarkable fungus-growth on paper.—Mr. V. Ball exhibited a specimen of meteoric iron from Glorieta Mountain, New Mexico.

PARIS

Academy of Sciences, January 25.—M. Jurien de la Gravière, President, in the chair.—Remarks in connection with a heliographic engraving representing the aërostatic experiments at Chalais-Meudon presented to the Academy by M. J. Janssen.—Studies on a phanerogamous plant (*Cymodoceites parisiensis*) belonging to the order of the Naiadeæ, which flourished in the marine waters during the Eocene epoch, by M. Ed. Bureau. This new genus, which is named Cymodoceites, in consequence of its numerous points of analogy with the genus Cymodocea, was widely diffused over the Paris basin, and tends to confirm the Indian affinities of the Middle Eocene flora already revealed by Ottelia, Nipadites, *Nerium parisiense*, &c.—Description of a differential sphygmograph invented for the purpose of easily demonstrating the peculiar veinous circulation "by influence" discovered in 1875, by M. Ch. Ozanam.—Further observations and studies on the parthenogenetic reproduction of the Phylloxera of the vine, by M. P. Boiteau. The fifteenth generation, obtained during the year 1884 by cultivation in tubes, was increased by a new series of four generations in 1885. All are at present hibernating, and appear to show no symptoms of degeneracy. Nevertheless the Phylloxera, after a prolonged existence, will probably become less vigorous, and, like the oïdium, anthracnose, and mildew, may cease to be destructive to the plants which it infests.—Note on the comet recently discovered by M. Fabry at the Paris Observatory, by M. Weiss.—Orbit and ephemeris of Fabry's comet, calculated by M. Lebœuf. The elements of the orbit deduced from observations made at Paris on December 1 and January 10 are as under:—

$$T = 1886 \text{ April } 6,\ 1372, \text{ Paris Mean Time}$$

$$\left.\begin{aligned} \omega &= 126^\circ\ 30'\ 48''{\cdot}0 \\ \Omega &= 36\ \ 23\ \ 29{\cdot}1 \\ i &= 82\ \ 46\ \ \ 5{\cdot}5 \end{aligned}\right\} \text{Mean Equinox of } 1886{\cdot}0.$$

$$\log q = 9{\cdot}808992$$

—Determination of the error of the constant of astronomical refraction by meridian observations, by M. A. Gaillot.—Note on the residuums of the double integrals, by M. H. Poincaré.—On the theory of linear equations, by M. E. Goursat.—Note on telemicrophonic instruments, by M. E. Mercadier. By telemicrophone the author understands a combined apparatus simultaneously producing the effects of the microphone and telephone, and reversible like the latter. He has constructed instruments of this kind, for which he claims the following advantages over the ordinary microphone: the possibility of a double mode of transmission with the same apparatus; reversibility of the transmitter, whereby the reception is greatly simplified; reduction of the number of organs on the microphonic posts, and consequent diminution of the total resistance of the apparatus on the same line. By this reduction the construction of the instrument may also be simplified, and its size considerably reduced.—Observations in connection with Prof. Langley's recent note on the hitherto recognised wave-lengths of light and sound, by M. Henri Becquerel. The statement attributed to the author by Prof. Langley that the most extreme radiations whose existence has been experimentally determined, do not reach a wave-length of 0·0015 mm., is denied, because the limit of observation depends essentially on the nature and delicacy of the methods employed to reveal the presence of ultra-red invisible rays.—On the transmission of copper through a volume of gas, and on the direct combination of copper with nitrogen, by M. R. Blondlot.—On some properties of the sulphur of antimony, by M. A. Ditte.—On a reagent, by means of which it may be possible to detect the acid function of the weak acids, by M. R. Engel.—On the composition of brandies distilled from wine, by M. Ch. Ordonneau. In order to ascertain the cause of the difference between neutral spirits distilled from grain, beet, potatoes, &c., and true wine brandies, the author has made a series of analyses, from which it appears that the unmistakable flavour of the latter is due to the presence in small quantities of a terpene boiling at 178° C., and whose products of oxidation are characteristic of old brandies.—On the digestive apparatus of the Phylloxera (*Ph. punctata*), by M. Victor Lemoine.—Note on the comparative morphology of the labium in the Hymenoptera, by M. Joannes Chatin.—Zoological and anatomical observations on a new species of Balanoglossus (*B. sarniensis*), discovered in the month of August 1885 at the island of Herm, a little east of Guernsey, by M. R. Kœhler.—Note on the roots of the Calamodendreæ (*Calamodendron striatum, C. congenium*, &c.), by M. B. Renault.—On the pollinic tube and its physiological *rôle*; a new reaction of the deposits improperly called cellulose knots, by M. Ch. Degagny.

BOOKS AND PAMPHLETS RECEIVED

"The Pictorial Arts of Japan," part i. section 1, General History: Wm. Anderson (S. Low and Co.).—"Calendar of University College of South Wales and Monmouthshire," 3rd Session, 1885 and 1886 (Owen, Cardiff).—"Proceedings and Transactions of the Royal Society of Canada for the Year 1884," vol. ii. (Dawson, Montreal)—"Elements of Chemical Physics," 4th Edition: J. P. Cooke, Jun. (Macmillan and Co.).—"A Text-Book of Deductive Logic," 2nd Edition: P. K. Ray (Macmillan and Co.)—"The Year-Book of Treatment for 1885" (Cassell).—"Dogs in Health and Disease": J. S. Hurndall (R. Gould).—"Modern Science": Edward Carpenter (Heywood).—"Chemistry of the Non-Metallics": Dr. E. B. Aveling (Hughes).—"The Reign of Law in Medicine": Dr. Dyce Brown (Trübner).—"University of Wales Calendar, 1885-86" (Cornish, Manchester).

CONTENTS

THURSDAY, FEBRUARY 11, 1886

PRECAUTIONS AGAINST HYDROPHOBIA

THE frequency of the terrible and incurable disease known as hydrophobia has led to precautions being adopted in London, which, if universally carried out, would probably rid us of the plague.

The recent progress of scientific pathology, *i.e.* of medical knowledge which advances by the methods of observation and experiment—has made clear much which was previously obscured by traditional fables.

It is now certain that hydrophobia is a real disease, not the mere result of fright, not primarily a mental disorder at all, but a definite sequence of bodily symptoms. Even its anatomy has been investigated by the beautiful methods of modern microscopical research; and the coincidence of the results obtained by skilled histologists, working independently, makes it probable that the lesions discovered are essential and not accidental. If so, the anatomical part of the disease consists in a perivascular inflammation of the central nervous system, and particularly of the part known as the "bulb," or *medulla oblongata*, which is situated between the spinal marrow and the brain. Moreover, it has been ascertained that hydrophobia belongs to the group of "specific," or, as they were termed by the late Registrar-General, "zymotic," diseases, which always arise by contagion, and always "breed true." It is most improbable that it ever appears, either in man or animals, spontaneously or from common causes. In men and in brutes alike it follows the bite of a rabid dog, or other animal. How it first arose, and whether in dogs, wolves, foxes, cats, badgers, or in Carnivora before they were differentiated into the three groups of cats, dogs, and bears, with their several allied kinds—is quite unknown. But we have no historical knowledge of the origin of small-pox or measles, or even of diseases once thought to be unknown before modern times, such as syphilis, diphtheria, and cholera. The evolution of diseases, like that of the human beings and the brute creation they infest, is matter of speculation only.

Now there are three ways of dealing with these specific diseases. One is by treatment when they are fully developed. This is the business of the physician, and in many of them his treatment is so far effectual that, though prevention would be better than cure, yet cure is generally the result of rational treatment. But no effectual treatment of hydrŏphobia is known. In spite of the pretensions of charlatans and the constant attempts of physicians, no plan of treatment has yet been discovered which can show a single instance of success.

The second method is to arm the domain of life against an invading pest beforehand, instead of driving it out when already an entrance has been gained. This is the method first applied to small-pox by inoculation with imperfect success, and afterwards far more efficiently by Jenner's discovery of vaccination. No corresponding process of protection against other human diseases had been discovered until Pasteur's recent attempts to apply the principle to hydrophobia; but the same eminent *savant* had before devised similar inoculations to prevent more than one epidemic disease peculiar to domestic animals. We referred in a previous number to his system of inoculation as a preservative against hydrophobia, and since then the cases on which he has operated have multiplied. One difficulty of judging as to the efficacy of his method is that not more than half the persons bitten by rabid dogs develop hydrophobia; the poisonous saliva may have been wiped off the teeth by the clothing as it was penetrated, or the effusion of blood may have immediately washed it away, or some local application may have destroyed it. Another is that hydrophobia has such an uncertain and often protracted period of "incubation," more uncertain and more protracted than that of any other specific disease, varying from a few weeks, or even possibly a few days, up to eleven or twelve months, and in some rare cases reaching two years, or possibly a longer period. But now that Pasteur's inoculations have considerably exceeded a hundred in number, these sources of fallacy are more likely to be eliminated, and as the mass of evidence increases, and the time grows longer, a conclusion one way or the other will become inevitable.

There is, however, a third method of dealing with hydrophobia, independent of future possible treatment and of inoculation. It is what the late Sir James Simpson called "stamping out" the infection in the case of cattle-plague. If we could kill every rabid dog and wild animal throughout the world at once, we have reason to believe that hydrophobia would become of only historical interest. Happily it has never (so far as we know) been transmitted from one human being to another, so that it would not be necessary even to await the death of the victims already bitten before feeling secure. Destroy the disease in animals, and it would perish from among men.

But since the infection takes place in the great majority of cases by means of a dog's bite, it would be sufficient to prevent every rabid dog from biting. This of course is impossible: but if we could make a dog's bite a very rare instead of a very common occurrence, the chance of being bitten by a rabid dog would become indefinitely remote. If we could prevent dogs from biting one another, hydrophobia would cease from among dogs also. The rabid dogs would die innocuous. It has been proposed to draw the large canine teeth, but this would not entirely prevent dangerous bites, it could never be carried out thoroughly, it would give needless pain to intelligent animals, and in attempting to enforce it more bites would probably be inflicted on the operators than if the dogs had been let alone.

The only rational methods yet proposed of preventing, or rather of reducing, the number of dog-bites is first to diminish the number of dogs by imposing a higher tax on those kept as domestic animals, and by destroying ownerless, miserable, and half-starved curs; and secondly to prevent dogs biting when abroad by enforcing the use of muzzles. These may be constructed so as not to interfere with the animal breathing, perspiring, and even drinking with comfort, and yet to prevent his using his teeth.

Such muzzles are enforced and worn by a recent regulation of the Metropolitan Police, and troublesome as such interference with individual liberty (whether of dogs or their masters) is felt to be in this country, it may be hoped that the rational part of the community will see its reasonableness, and will do their best to have it thoroughly carried out.

Similar measures have long been enforced in Berlin and other Continental cities, and have been followed by the most gratifying results in the diminution or suppression of the dreaded hydrophobia.

BOTANICAL RESULTS OF THE "CHALLENGER" EXPEDITION

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. G. S. Nares, R.N., F.R.S., and Capt. F. T. Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Botany—Vol. I. By William Botting Hemsley, A.L.S. (Published by Order of Her Majesty's Government, 1885.)

THE botanical results of the voyage of the *Challenger* hitherto published have been confined to the reports of Mr. Moseley, sent home from time to time during the voyage, along with collections of plants made by him, to Kew, and published, along with lists of the species, in the *Journal* of the Linnean Society. In the volume before us we have the results of a more detailed working up of the material thus obtained so far as it belongs to insular floras. Mr. Hemsley, who is responsible for the book, brings to his task botanical experience which begets the liveliest confidence in the thoroughness and accuracy of the work, and the volume will certainly compare with any of those upon the zoological results of the voyage already published. It is necessary to emphasise the fact that Mr. Hemsley is the author of the book, for it is not patent on first inspection. The title-page, where one naturally looks for information upon the subject of authorship, tells that the volume is published under the superintendence of Mr. John Murray, who writes barely a page of preface, but it says nothing of Mr. Hemsley, the author of the rest of the book—over 900 pages—and it is only by turning up the table of contents that his connection with the book is found recorded. This may be consistent with uniformity in the appearance of the *Challenger* publications, but hardly, we think, with consideration for the author.

Although appearing amongst the scientific results of the *Challenger* voyage, Mr. Hemsley's work has a considerably wider basis than the botanical insular collections made during that voyage. From the rich stores of the herbaria at Kew and the British Museum he has sought out and made use of collections and records of observations of travellers, both old and recent, so far as they relate to islands from which Mr. Moseley procured specimens, and he is thus enabled to present an account of all that is known of the vegetation of these islands,—in some cases their complete flora. The book is, then, no mere descriptive synopsis of the botany of the *Challenger* Expedition. Its nature may be gathered from Mr. Hemsley's own description :—

"In the introductory notes on the vegetation of the various islands included in the reports on the botany of the Expedition are embodied tables showing the distribution of the genera and species of each island or group of islands. There are also observations on the composition, affinities, &c., of the different insular floras, together with references to the diverse agencies operating in the dispersal of plants, whilst numerous facts and suggestions bearing upon the same subject are scattered throughout the lists. Finally, the appendix to the third part of the botany is devoted to the record of evidence of the part played by oceanic currents and birds in the transport of seeds from place to place. The general introduction is not limited to a mere summary of the facts contained in the reports, and speculations thereon ; it has been so extended as to form an epitome of the botany of a large number of oceanic islands and of the Antarctic regions generally. The special characteristics of insular vegetation in various parts of the world are set forth and compared with continental vegetation ; and, as a whole, the work may perhaps serve as an indication to travellers of the nature and extent of the observations required for the advancement of this most interesting subject."

As to method the book is divided into four parts. The first is a "Report on the Present State of Knowledge of various Insular Floras," being an introduction to the botany of the *Challenger* Expedition. The second and third parts are Reports "On the Botany of the Bermudas and various other Islands of the Atlantic and Southern Oceans," namely, St. Paul's Rocks, Fernando Noronha, Ascension, St. Helena, South Trinidad, Tristan d'Acunha Group, and St. Paul and Amsterdam Islands, and the chain of islands from the Prince Edward Group to the Macdonald Group. The fourth part consists of a "Report on the Botany of Juan Fernandez with Masafuera, San Ambrosio, and San Felix, the South-Eastern Moluccas, and the Admiralty Islands," to which is added an Appendix "On the Dispersal of Plants by Oceanic Currents and Birds."

The scope of the volume is so comprehensive, and the subject is in touch with so many of the interesting problems connected with plant-distribution, that in this notice we must content ourselves with merely indicating some of the more prominent features that characterise the book. At the outset we may state that it abounds with interesting and new facts, and the analytical tables graphically representing various facts of distribution, compiled evidently with great care, are exceedingly striking, and bring out contrasts in a manner no amount of writing could effect.

The introductory part is really a series of essays upon various interesting subjects connected with phytogeography, which are mainly treated in their bearing on insular floras. An early chapter deals with the classification of islands in relation to the composition of their vegetation. Wallace's classification of oceanic and continental islands, whilst harmonising with the features of vegetation of many islands, is not adapted, Mr. Hemsley thinks, for exhibiting the floral peculiarities of islands generally. The Bermudas and Galapagos, for example, included in Wallace's oceanic group, cannot be fairly placed in the same category. He therefore proposes a classification which in effect, so far as it is applied in this volume, amounts to the subdividing of Wallace's oceanic group into ancient, more recent, and new sub-groups. Islands may be arranged, he says, for phytogeographic purposes, in three categories, according to their endemic element, namely:—(1) Those with "vegetation comprising a large endemic element, the nearest affinities of which are not always found in any one continent"; to this category belong St. Helena, Juan Fernandez, the Sandwich, Galapagos, and Seychelles Groups. (2) Those with "vegetation comprising a small, chiefly specific endemic element, the origin of which is easily traced"; here are included the Bermudas, Azores, Ascension, the islands in the southern part of the Indian Ocean, and the Admiralty Islands. (3) Those with a "vegetation comprising no endemic element" (which have become stocked with plants in very recent times); such are the Keeling and other coral islands in the Indian and Pacific Oceans. A statistical account of floras of several islands not treated of in detail in the subsequent reports is given to illustrate the feature characteristic of these several categories.

A very prominent place is given by Mr. Hemsley to the question of the "dispersal of plants by oceanic currents and by birds." In the appendix to Part III. there are descriptions of drift-seeds and seed-vessels, and of seeds and fruits from the crops of birds, collected by Mr. Moseley, Dr. Guppy, and others, to which is prefaced an historical *résumé* of the subject. We have in fact an epitome of all that has been written upon the subject up to the present time. The evidence Mr. Hemsley brings forward of the potency of these agencies in plant-dispersion is irresistible, and effectively overthrows the opinion so frequently expressed by Alphonse de Candolle—an opinion founded in great part upon the capacity of seeds to retain vitality when immersed in sea-water, as determined by experiment—that oceanic currents have played and play an unimportant part in plant-diffusion. The views of the two botanists are placed in striking contrast by a comparison of the list of species certainly or probably dispersed by ocean currents given by each: De Candolle's contains about two dozen, Hemsley's over 100. Mr. Hemsley guards himself against being supposed to regard the sea as the principal agent, or indeed as anything more than a subordinate agent in bringing about the present distribution of plants, "for it is manifest that the action of currents and birds of passage are insufficient to account for certain elements in the vegetation of many islands." But at the same time he goes so far as to maintain that the littoral flora owes its present characteristics to the fact that the seeds of the plants composing it are capable of withstanding long immersion in sea-water, and are thus suited for oceanic transport. That the present general diffusion of a large proportion of the plants inhabiting the tidal forests and sandy and muddy sea-shores of the tropics is in a great measure due to oceanic currents is, in his opinion, quite certain from the evidence; a view from which few, we imagine, will be inclined to dissent. In illustration of this subject he gives (taking a small selection of flowering-plants whose seeds are transported by oceanic currents and by birds) the following picture of the gradual invasion of an island by herbs, shrubs, and trees. "The seeds of many almost ubiquitous sand-binding grasses may be reckoned among those which are cast ashore in a vital condition, and we assume that these grasses are amongst the first flowering-plants to obtain a footing. Other herbaceous plants met with in the earliest stage of such an insular flora are *Portulaca*, *Sesuvium*, *Canavalia obtusifolia*, and *Ipomœa biloba* (*I. pes-capræ*); all of which seem to possess an unlimited power of colonisation. Moreover, they provide the conditions necessary for other plants to be able to establish themselves. Among the early shrubby occupants, *Suriana maritima*, *Pemphis acidula*, *Scævola Kœnigii*, and *Tournefortia argentea* are prominent, being found on the most remote islets of the Pacific and Indian Oceans within the tropical and sub-tropical zones. Where there are muddy shores, there the various mangroves (*Rhizophora*, *Bruguiera*, *Avicennia*, *Vitex*, &c.) take possession. Among the first real trees are *Heritiera littoralis*, *Hibiscus tiliaceus*, and *Barringtonia speciosa*, together with screw-pines. After this nucleus of a flora has been formed, it is comparatively easy for other arrivals to establish themselves; and every addition in a measure helps to provide the conditions for a still more varied vegetation." And he concludes:—"It may be safely assumed, therefore, that if oceanic currents and birds have not been the means of dispersing a large number of species of plants, and it is not certain that they have not, they are certainly the most important agents in stocking islands, for without their action the numerous remote coral islands, at least, would still be utterly devoid of phanerogamic vegetation, and consequently uninhabitable."

As a concrete illustration of the influence of these agencies in stocking islands, an analysis of the indigenous vegetation of the Bermudas is given, which shows that 45 species are chiefly littoral plants, the seeds having been probably conveyed to the island by oceanic currents; 38 are marsh plants, with small seeds, possibly conveyed to the island in mud adhering to birds, though many may have reached in vegetable drift; 13 are plants with more or less fleshy fruits, and probably were carried by frugivorous birds, leaving a very small number of species introduced, probably indirectly, by man.

In a chapter upon the Antarctic flora, and the origin of the vegetation of the islands of the South Indian Ocean, Mr. Hemsley subscribes to the view advanced by Sir Joseph Hooker, and maintained by others, that a former greater land connection in the southern hemisphere is necessary to account for the present distribution of the vegetation in this region, and that a northward migration of southern forms has taken place in the past, and has perhaps hardly ceased. He thinks a greater land connection than Wallace allows must have existed, though the continental extension demanded by Hutton is unnecessary. At the same time he admits that a land connection so great even as Wallace assumes, along with alternations of climate, removes many of the difficulties in the way of accounting for present distribution, and if Thiselton Dyer's hypothesis be accepted, that the northern hemisphere is the primary home whence a southward migration of the forms of vegetable life has taken place, he considers a sufficient explanation is obtained. But he dissents entirely from Thiselton Dyer's view, holding that "until more conclusive testimony is forthcoming of the former existence of *Proteaceæ*, *Eucalypti*, &c., in Europe, we cannot avoid the conviction that they originated in the south."

Mr. Hemsley points out that the absence of general structural peculiarities in insular plants, and the occurrence of their physiognomic features in many continental areas, adds to the difficulties of plant geographers. He shows that no order, no sub-order, not even a tribe, is endemic in the smaller oceanic islands, and that the very distinct genera that occur are not disproportionate. To the question, Do the flowers of endemic insular plants present any peculiarities of size, shape, or colour? we get an instructive answer in the tabulated analysis of the endemic plants of St. Helena. From it we learn that "the size of the flowers and flower-heads in this flora is on the whole rather above than below the average of those of their allies in other parts of the world. When we come to colour, however, the equality fails altogether, red being almost entirely wanting in the insular plants, and blue unknown." The absence of butterflies and the abundance of moths on the island is a significant concomitant circumstance, as Mr. Hemsley remarks. Particulars are not yet forthcoming from other islands to permit of like analysis, and Mr. Hemsley merely concludes that brilliantly-coloured flowers are rare in such islands.

Amongst the special features of insular floras discussed and illustrated by Mr. Hemsley in the introductory portion of the volume, is the preponderance of shrubby and arboreous Compositæ, and of woody plants generally. That islands "often possess trees and bushes belonging to orders which elsewhere include only herbaceous species" as Darwin stated, he shows, by tabulated evidence of the occurrence of arboreous or shrubby forms allied to insular ones upon continental areas, requires modification. To illustrate the difficult problem of the absence or rarity of large, almost ubiquitous, orders in oceanic islands, he selects Leguminosæ, Orchideæ (the table showing the absence of species or the number of species of Orchideæ in various islands is extremely interesting), and Gymnospermæ; and the concomitant rarity of insects is suggested as a probable explanation so far as the first two orders are concerned. We cannot further notice these and other fascinating subjects dealt with by Mr. Hemsley in the introduction, but must recommend botanists and all interested in the subject of plant-distribution to peruse the volume, where, in addition to the information imparted by Mr. Hemsley himself, they will find a serviceable bibliography of insular floras and an index of islands with the names of authors who have written about them.

In the introductory notes to the several floras in the second, third, and fourth parts of the book Mr. Hemsley manages to convey a vast deal of information. Accounts of the physical features, the history of the island, as well as analyses of the vegetation are given, and he finds room for illustrative extracts from the works of travellers who have visited the islands. Many interesting subjects crop up in these—for example, the question of the sandal-wood in Juan Fernandez; but space forbids our noticing them. It needs, however, little examination of this portion of the book to convince one of the genuine character of the work which has been put into the preparation of the floras. The synonymy, the distribution, the critical notes, and the general information regarding each species, all testify to a conscientious search after completeness and accuracy, the result being a thoroughly trustworthy record of what is at present known regarding them. One point we may criticise unfavourably. We notice Mr. Hemsley has adopted the system of writing all specific names with a commencing small letter. This, though a prevailing custom with zoologists, is an innovation in botanical description in this country, and without discussing methods of nomenclature, which would be beside our purpose here, we would simply say that we do not agree with Mr. Hemsley in admiring it.

We have only been able to touch upon a few points in this excellent volume, sufficient, we hope, to indicate its importance. Problems of plant-distribution meet us frequently throughout the volume, and Mr. Hemsley's work is a most important contribution towards their solution. Of especial value is his treatment of the subject of the sea and birds as factors in distribution. A somewhat disjointed character in the book and frequent repetition are defects which are perhaps inseparable from the method of its preparation. For inequalities the author apologises, and the merit of the book as a whole fully atones for them. Mr. Hemsley's deservedly high reputation as a systematic botanist, confirmed by his "Botany of Central America," now approaching completion, is still further enhanced by this his most recent work.

We may add that the volume is illustrated by many excellent plates, chiefly drawn by Miss Smith.

Besides bearing witness to the good fortune which placed the making of botanical collections during the voyage of the *Challenger* in the hands of so able a naturalist as Mr. Moseley, the volume testifies in a very emphatic manner to the inestimable value of our national herbaria, especially that at Kew. Collections of plants, small and incomplete in themselves, are there accumulated ready for use when occasion requires, forming the material from which such volumes as this we notice may be constructed. We cordially join Mr. Hemsley in his hope that his work may direct attention to the nature and extent of the observations required from travellers for the advancement of our knowledge of the subject of plant-distribution, and we may conclude with one other aspiration. There is at present no authoritative book in our language on the subject of botanical geography, and too many of the phytogeographical works published nowadays are purely statistical compilations. Is it, then, too much to expect from the pioneer in the philosophical treatment of plant-distribution, Sir Joseph Hooker, whose name is in so special a manner associated with the subject of insular floras, a comprehensive work on botanical geography such as he alone could write? We hope not.

HALSTED'S "ELEMENTS OF GEOMETRY"

The Elements of Geometry. By G. Bruce Halsted. (New York: John Wiley and Sons, 1885.)

MR. HALSTED is already favourably known to English mathematicians by an excellent "Elementary Treatise on Mensuration" (published in the summer of 1881), and by one or two carefully compiled bibliographies in the *American Journal of Mathematics*. The faithful chronicler records of Tom Tulliver that he called his Manual of Geometry "the exasperating Euclid," a title richly deserved if his desire to be excused the "doing" of it were really based upon the reason he assigned, viz. "It brings on the toothache, I think." Now we have not an annotated copy of the "Mill on the Floss," and so cannot identify the particular edition which produced such a wretched result, but we doubt not it was one of the ordinary small text-books with which youth were well acquainted, in shape at least, at the time referred to. And this makes us allude to the portentous dimensions of the book before us, which consists of some 370 large octavo pages. The book is not for schoolboys, but is intended for students of larger growth. It commences, as does also "The Elements of Plane Geometry" (brought out by the Association for the Improvement of Geometrical Teaching), with a preliminary chapter on Logic, which gives sufficient introduction to a subject in which "the mind first finds logic a practical instrument of great power."

We turn aside for a moment to state a *raison d'être* for the volume before us. "In America the geometries most in vogue at present are vitiated by the immediate assumption and misuse of that subtile term 'direction'; and teachers who know something of the non-Euclidian, or even the modern synthetic geometries, are seeing the evils of this superficial 'directional' method. Moreover, the attempt, in these books, to take away by definition from the familiar word 'distance' its abstract character and connection with length-units, only confuses the ordinary student. A reference to the article *Measurement*, in the 'Encyclop. Britannica' will show that around the word 'distance' centers the most abstruse advance in pure science and philosophy. An elementary geometry has no need of the words 'direction' and 'distance.' The present work, composed with special reference to use in teaching, yet strives to present the elements of geometry in a way so absolutely logical and compact that they may be ready as rock-foundation for more advanced study."

This lengthy extract puts our readers in possession of Mr. Halsted's views: the result of his efforts is an edition which will, we think, repay perusal.

Now, in reply to old Tulliver's query, "Wat's Euclid?" it was replied, "It's definitions, and axioms, and triangles, and things. It's a book I have got to learn in—there's no sense in it." (Such is the view of some boys of the present day, as we discovered in looking over answers to a recent examination paper.)

Mr. Halsted defines a straight line thus:—It is a line which pierces space evenly, so that a piece of space from along one side of it will fit any side of any other portion. In his definition of an angle (AOB) one of the angles is said to be the *explement* of the other; he uses the term "straight angle," calls a terminated line (as in his "Mensuration") a *sect*, and "the whole angle which a sect must turn through, about one of its end points, to take it all around into its first position, or, in one plane, the whole amount of angle round a point, is called a *perigon*." Other definitions do not call for notice, except that in the definition of a circle he has, by an oversight, omitted to state that the sect must revolve in a plane.

The First Book is divided into eight chapters, and embraces the matter of Euclid's First Book, with several other important propositions: the order is not that of Simson's text, but propositions are grouped under problems, inequalities, parallels, triangles, and polygons. This last head is broken up into the divisions, general properties (congruence), parallelograms, equivalence, and axial and central symmetry.

In Book II. the commutative law (for addition and multiplication), the associative law, and the distributive law are established, and the propositions proved symbolically. Books III., IV., V., and VI. correspond to Euclid's divisions, but the selection of propositions and their arrangement and treatment agree with results we have seen nearer home.

But we hasten to a close, remarking that the remaining books treat of planes and lines (VII.); tri-dimensional spherics (VIII.); two-dimensional spherics (IX.); polyhedrons (X.); mensuration or metrical geometry (XI.) in five chapters, length, area, ratio of a circle to its diameter, measurement of surfaces, space-angles, and the measurement of volumes. The work closes with short paragraphs on direction, principle of duality, linkage, and cross-ratio.

There are some 234 exercises grouped together at the end, and also interspersed throughout the text.

There are a few typographical errors and a few slips in statement, and very many novel terms, *i.e.* to persons who have not read the "Mensuration" referred to above. We understand that the book is about to be published in this country, when geometers will be easily able to procure a copy for an examination, which will not be unattended, we believe, with profit.

The figures are in the main carefully drawn, though some few require correction.

OUR BOOK SHELF

The Zoological Record for 1884. Edited by Prof. F. Jeffrey Bell, M.A. (London: John Van Voorst, 1885.)

We have to congratulate the *Zoological Record* Association on having brought out this the twenty-first volume of the *Record* within the year. The publication of the *Zoological Record*, begun in 1865, was continued from 1871 by this Association, which well deserves every encouragement that the biologist can give to it. It would be a deep disgrace to our British School of Natural History if so valuable a work should be allowed to come to an end after having well and bravely struggled for existence for one-and-twenty years. At present the Association numbers only fifty-three members and seventy-one subscribers, in addition to which several of our public libraries no doubt take their copies from the publishers; but to make the Association a self-supporting one, it should have a couple of hundred new subscribers, and such a number ought to be had from among the numerous students of zoology in this country. A vigorous effort now made might mark this year in the history of the *Zoological Record* as one of financial success.

While writing thus of the present, our thoughts also wander to the past. Although none of the original writers for the *Record* have gone to their long account, yet with the present volume, the last of them, Prof. E. von Martens, ceases from his *Record* labours, and his place is to be taken by four very excellent recruits,—Prof. Herdman, Messrs. W. E. Hoyle, G. R. Vines, and G. H. Fowler. The only one of the Recorders who kept in the race for the whole of the twenty-one years—Prof. von Martens—had all through the great group of the Mollusca to record, and then, on the dropping out of the ranks of other Recorders, he took the Molluscoida and Crustacea. It is not possible to part with such a contributor without publicly recording the great debt that all interested in zoology owe to him for his labours.

One other contributor, also of long standing, now parts company from his comrades. On Mr. Kirby had fallen the parts of Dallas and Rye. No less than Prof. von Martens he deserves our thanks. His part we are delighted to know will be for the future filled by Dr. Sharp.

The editor's preface opens with a few feeling words relating to the death of the late editor, E. C. Rye; he is also obliged to record a broken promise, which thus recalls to mind an almost similar one recorded in vol. i., but with this difference—that for vol. xxi. though at the last hour a Recorder was found to supply the not forthcoming record, and has done so in a manner that, novice though he may be, shows the master's hand, for Mr. P. L. Sclater's record of the Mammalia forms not alone a scientific record, but its arrangement and style is so good and the summary of work on the general subject is so excellent as to mark it out for special notice.

Mr. Bowdler Sharpe, owing to his visit to Simla, left the record of the birds to Mr. A. H. Evans.

Mr. Gibson-Carmichael, in his record of Arachnids for 1883 and 1884, apologises for not recording a list of the new species described in the papers quoted owing "to his not feeling competent to judge of the value of new species." Here we may be allowed to utter a word of caution. A record should not of necessity be a criticism, and we would have preferred to have seen a statement of all the new species and their habitats than merely the titles of papers. For a zoological inquirer the habitat is often an assistance, and we notice that the same Recorder has not in the case of the Myriapoda been as particular in quoting these as we could have wished. Prof. Haddon has recorded the Infusoria. Certain very desirable changes in the sequence of some of the groups have been made by Prof. Jeffrey Bell, who acknowledges the receipt of money grants in aid of the publication from the Government Grant Committee of the Royal Society and the British Association, and whom we wish every success in his arduous and difficult task as editor of our British Record of Zoological Science.

Elemente der Lithologie. Von Dr. Ernst Kalkowsky. (Heidelberg: Carl Winter, 1886.)

THIS is an attempt, and a very successful one, to present to the student an elementary treatise, which shall be at once brief but well up to date; a difficult task in the case of a subject of which our stock of knowledge is being continually increased by results scattered through, or buried in, countless separate memoirs. The work is without figures, and is compressed into 316 pages, the first 57 of which are given to a general and introductory discussion of the characters of rocks and the methods of investigation. The reader's sound knowledge of the principles of chemistry, mineralogy, and physical optics is assumed by the author. The classification used in the larger treatises is generally adhered to. The arrangement of the information relative to each rock-family is very neat and compact: first is given a list of chemical analyses, and next a description of the macroscopical and microscopical characters of the component minerals; then follow accounts of the modes of occurrence, alteration, and genesis; and finally a short description of the varieties. The work is altogether satisfactory.

Notions Générales sur l'Éclairage Électrique. Par Henry Vivarez. (Paris: J. Michelet, 1886.)

THIS is a second edition of one of those readable and well-illustrated *brochures* that the French know so well how to write, and that have such a ready sale in their country, but which fail to secure even a publisher in this. The author is known in this country principally as a contributor to *Engineering*. His name has not been associated with any electric light enterprise, but he clearly understands that which he writes about. There is not much in the book that is new, indeed there is much that is obsolete, but what there is is clear and comprehensive. That which is French has naturally a preference over that which comes from "barbarians." The chapter on meters and photometers is excellent. The following table is useful:—

One carcel = 8·3 English standard candles.
= 7·5 German " " "
= 6·5 Munich " " "
= 105 litres per hour of gas

The work is not scientific. It is popular, readable, and useful.

Rome in Winter and the Tuscan Hills in Summer; a Contribution to the Climate of Italy. By David Young, M.D. (London: Lewis, 1885.)

THIS little volume must prove of practical value to a considerable class of people, that class which every year furnishes a large contingent of visitors to Italy and winter residents in Rome. Dr. Young has himself long resided in Italy, and has had ample opportunity of observing its climatal and sanitary conditions. He shows in his instructive book that Rome has got an undeservedly bad name for its climate, and the object of the volume is to show exactly what that climate is, under such heads as —the climate of Rome and its effects upon health and disease; the unhealthiness of Rome; Roman fever and malaria; water-supply of Rome; how to live in Rome; class of invalids likely to derive benefit from a residence in Rome, and so on.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Barometric Pressure in the Tropics

THE American Eclipse Expedition to the Caroline Islands in May 1883 also made exceedingly interesting meteorological observations, of which the most important are those on the pressure of the air, as they elucidate some points in the daily period of this phenomenon (*Memoirs* of the National Academy of Sciences, vol. ii.). As this is very regular in the tropics, any difference in it points to exceedingly potent influences, and it is easy to surmise that, in the daytime, *none, except a cyclone, can be more potent than an eclipse, as no other can shade the whole extent of the atmosphere*. The result was an accelerated diminution of pressure from 10.15 to 11.30 a m. (totality 11.32 to 11.37 a.m.), then a rise to about noon—*i.e.* at a time when there is generally a great fall—and later again an accelerated fall. The explanation is probably the following:—The accelerated fall at the beginning is caused by the diminished temperature and elasticity of the air. Then, as the height of equal pressure diminished in the shaded area, air began to flow in from the vicinity, causing a rise of pressure, and the subsequent rapid fall was a return to the normal condition.

The next total eclipse is to be on August 29 next, being visible in the morning on the Isthmus of Panama, the Leeward Islands, then Tobago, Grenada, the Grenadine Islands, and Barbados, and in the afternoon in South Africa from Benguela to Mozambique and the southern part of Madagascar. It would accordingly be important to have half-hourly barometrical observations (self-recording barometers or aneroids would be better still) at many points both of America and the adjacent islands and of Africa. We should expect to see the morning rise of pressure interrupted on the Antilles Islands (totality 7.23 a.m. at Barbados), and the afternoon fall of pressure also interrupted in Africa (totality 3.10 p.m. at Benguela).

The varying cloudiness in America and the Antilles (as the rainy season there has not the steadiness of the Indian monsoon and does not exclude clear days) would add a feature of even greater interest, as the influence of the eclipse on the daily period of pressure in clear and cloudy days could be compared. In South Africa, except the coast, where fogs are frequent at this season, clear weather prevails, and thus there is much more hope of good observations of the eclipse. As to pressure observations, they would be most interesting at some distance from the coast. A. WOEIKOF

St. Petersburg, January 24/February 5

Parallel Roads

THE following, from an old note-book, may be of interest in connection with this subject :—

I observed, in 1881, the formation of parallel roads on a small scale still in progress in a small plain about 3 miles long and 1 broad, marked in maps of Iceland as a lake, Sandkletta-vatn (lat. 64° 21′). This was surrounded on three sides by mountains, and the fourth was closed by a lava-stream. The plain is a perfect level of dark sandy mud without a vestige of vegetation, and is evidently a shallow lake for the greater part of the year. The shore is regularly terraced, the terraces being 2 or 3 feet apart. I thought at the time that the water must be dammed back regularly during the winter to a certain height, but that this height has diminished at three successive periods owing to fresh channels being found through the lava at lower elevations. In Goddalir there is a most instructive example of the formation of river-terraces. Above the broad valley there are two groups, over 1000 feet deep, terminating in a vast glacier or ice-cap. These seem to have been filled in solid with moraine, the remains of which still cling to the sides at all elevations. The eastern one evidently became cleared out first, with the result that an enormous mass of gravel was spread over the whole width of the valley below. The western one next started a torrent of its own, which cut down the level for some distance on its own side to 30 or 40 feet lower. Finally, both torrents united, and their greater transporting power again cut down the level some 30 feet, with the result that there are now two level terraces and the basis of a third. J. STARKIE GARDNER

Colours in Clouds

THE coloured fringes to, and in, clouds I long ago found to be very common, but I had no idea that there was any novelty, as there would seem to be, in this fact.

When the sun is setting behind a bank of clouds and there are high cumulo-strati or strati, these will almost always, I believe, be found coloured, at the proper distance from the sun, if viewed through a suitable dark glass. The edges of the dark cloud will often be so too. I believe these colours are always present; hidden by the brightness of the cloud which shows them, and the glare of the lower air. The former is removed by the dark glass, the latter by the interposition of the bank.

The tint I believe depends on the density of the cloud where it is formed. But it seems more probable that the real cause is that the particles (of ice?) are larger and more numerous where the cloud is more dense, and that, if their size were increased independently of the density we should have exceptional cases.

I have seen these fringes to bright edges of dense cumulus, but I must own that I never was quite satisfied that I was not seeing two strata of cloud. The colours are very beautiful, and often so strong that it is difficult to realise that the dark glass has only removed a concealing glare. J. F. TENNANT

Ealing, January 29

Movement of Telegraph-Wires

I HAVE frequently noticed the peculiar movement of telegraph-wires noticed by your correspondent. For some time I took it to be an ordinary case of vibration, but it presented so many peculiar features that I was induced to examine it more closely. It frequently happens that when the temperature and dew-point of the air are at or about the freezing-point, and the sky is clear, the wires are chilled by radiation, and hoar-frost is deposited upon them. With an almost imperceptible wind the hoar-frost collects almost wholly upon one side of the wire in the form of a wing, producing a torsional strain. The weight of the hoar-frost, as compared with the weight of line, is so small that their common centre of gravity is almost coincident with the centre of the wire. When in this condition, if a light wind acts upon the frozen wing, it imparts a reciprocating rotary motion to the wire. Each time the vibration brings the plane of the protuberance in a line with the eye, the wire almost disappears from sight, while when it is at right angles to that line it flashes suddenly into view. If looked at from such a point that the wing of hoar-frost moves backwards and forwards behind the black wire, the effect is very much more marked.

R. MOUNTFORD DEELEY

Mill Hill, Derby, February 2

The Deltas of Glacial Rivers

AN interesting fact connected with the Lake of Geneva has recently been brought to light by M. Hörnlimann, who is now preparing a hydrographical chart of the Leman basin. From the point where the Rhone enters the lake, to a distance of more than 6 kilometres, the river-water, which is denser than the lake-water, follows a trench in the alluvial deposits which is from 500 to 800 metres wide, and which, even beyond St. Gingolph, where the depth exceeds 200 metres, is 10 metres deep. A precisely similar groove has been observed at the mouth of the Rhine in the Lake of Constance, with a depth of 70 metres and a width of 600 metres; and similar though less deep grooves are found opposite to the old mouths of the Rhone and the Rhine in the two lakes. The greater density of the river-water is owing to its lower temperature and to the vast quantity of sediment suspended in it. The deltas of glacial rivers flowing into lakes differ, then, in a remarkable manner from the deltas of most rivers flowing into the sea; the water of these rivers, being less dense than that of the sea, spreads over the surface, and thus helps to form bars. G. H. W.

MAHWA FLOWERS

ATTENTION has been publicly drawn of late to "Mahwa Flowers"—the corollas of *Bassia latifolia*—as a cheap source of cane-sugar. This species of Bassia is a tree attaining to a height of 40 to 60 feet, and common in many parts of India, especially in Central Hindustan. It has oblong leaves of firm texture, from 5 to 6 inches long; these fall in February, March, or April, and are succeeded in March or April by the flowers. These last for two or three weeks and then begin to fall. The falls take place at night, and continue sometimes for a fortnight. The fruits, which resemble a small apple, ripen in three months; the seeds, one to four in number, yield an edible oil by pressure. It should be added that the trees are self-sown, and that they flourish in very poor and stony soil.

When the Mahwa tree is in bud, the ground beneath it is cleared of weeds, sometimes by burning. A single tree may yield as much as six to eight maunds[1] of flowers; even thirty maunds have been asserted to have been collected from one tree. These flowers have a luscious but peculiar taste when fresh; when dry they resemble in flavour inferior figs. They form a very important addition to the food of the poorer classes in those districts where the tree abounds, particularly in the neighbourhood of woodlands and jungles. They are specially useful in economising cereals in seasons of famine and drought. They are sometimes eaten fresh, but more commonly sun-dried, and are usually consumed with rice and the lesser millets, or with seeds of various kinds, and leaves. It is said that a man, his wife, and three children may be supported for one month on two maunds of Mahwa flowers.[2]

It is not, however, as a direct article of food, nor as a material for the preparation of a rough spirit by fermentation (a very common use of these flowers) that Mahwa blossoms are now recommended. It has been affirmed that they may be employed as an abundant and very cheap source of cane-sugar. In the *Morning Post* of October 15, 1885, appeared an article on this subject, in which it was stated that, "If the Mahwa flowers be available in sufficient quantities for the sugar-makers of Europe, there can be no question that the days of the

[1] A Bengal maund equals 82¼ lbs. av. irdupois.

[2] For an interesting account of the Mahwa tree and its products, see a paper by E. Lockwood in the *Journal* of the Linnean Society ("Botany"), vol. xvii. pp. 87–90.

beetroot are over, and sugar-cane will go the way of all discarded products." This prediction depends, however, upon another condition besides that of the abundance of the flowers. If the sugar they contain be wholly or chiefly cane-sugar, that is, "sucrose," then the argument is not without weight. But the nature of the saccharine matter of the Mahwa does not appear to have been ascertained. MM. Riche and Rémont (*Journ. de Pharm. et Chimie*, 1880, p. 215) stated that the air-dried flowers contain 60 per cent. of fermentable sugar, of which about one-seventh is crystallisable. The material available for analysis in Europe consists, of course, of the dried flowers. These may have suffered some change beyond the mere loss of water, but the evidence they afford on chemical examination is not favourable to the view that they are likely to compete with sugar-beet or sugar-cane as a source of cane-sugar. Here is the result of an analysis of a sample of Mahwa flowers (from the Kew Museum) in their air-dried condition :—

	In 100 parts
Cane-sugar	3·2
Invert-sugar	52·6
Other matters soluble in water	7·2
Cellulose	2·4
Albuminoids	2·2
Ash	4·8
Water lost at 100° C.... ...	15·0
Undetermined	12·6

The flowers analysed had a slight smell of fermented saccharine matter and a distinct acid reaction. But it is not at all probable that they could have contained any large proportion of cane-sugar even when quite fresh, and that 15/16ths of that sugar had been inverted during the process of desiccation. We cannot argue from analogy in this case. For while the nectar of many flowers contains no sugar except sucrose, invert-sugar occurs in some blossoms, as well as in many other parts of plants. Even the unripe and growing stems of the sugar-cane and of many grasses contain much invert-sugar. It must, however, on the other hand, be remembered that cut sugar-canes imported into this country contain a large amount of invert-sugar, and that if they be kept a week only after the harvest the invert-sugar naturally present in the juice shows a marked increase and the cane-sugar a corresponding diminution. On the whole, then, so far as the materials at my disposal enable me to judge, I believe that the saccharine matter of fresh Mahwa flowers will be found to consist mainly of dextrose and levulose, and that consequently they will not be available as a material for the economic production of sucrose.

I have to thank Mr. W. T. Thiselton Dyer, C.M.G., Director of the Royal Gardens, Kew, for drawing my attention to this subject, and for a supply of the material on which I have worked. A. H. CHURCH

THE UNIVERSITY EXTENSION MOVEMENT[1]

THIS "movement" is one of the most significant of the present day, and provides a most useful step in that ladder of learning which it is desirable to see reaching from the elementary school up to the University degree.

Under the University Extension system, knowledge of the highest character is offered by its acknowledged possessors to all classes alike, yet with the very popular qualities of cheapness and attractiveness. The contents of this paper fall naturally into two heads : first, the advantages offered and the objects aimed at by those engaged in the work ; and, secondly, hints and instructions as to the methods by which the work may be successfully carried on. Mr. Moulton vigorously urges the former, and has ten years' experience in the latter.

The ideal aimed at is, that a University education should be placed within the reach of any "person" in any grade of society, and that large bodies of students all over the country should be attached to the University as associates, of whom, if few ever became full members, yet any might do so, and all have started on the road. The Universities have set themselves to meet the wants of classes who have been long debarred from such privileges ; and an ample page of knowledge will be spread before the eyes of all whom partial education may lead to seek it yet further.

The desire has long been felt both among middle and lower classes. The old Literary and Philosophical Society on behalf of the one, and the old Mechanics' Institute of the other, were both anxious attempts to do, by voluntary effort and amateur work, what the University now offers to undertake as a special business, by means of an itinerant system of authorised teachers taken from their most highly-trained and successful graduates. Under the eye of the Syndicate, and not making popularity their end, they will have a power at their back and a guarantee of their quality and of its permanency which the old lecturers could never give.

The great difference, accordingly, from the single desultory lectures given at the old institutions is the thoroughness of the instruction aimed at under this new system rising by stages to the full studies of the University. No subject is undertaken in a set of less than twelve lectures ; notes are expected to be taken, the books recommended by the lecturer are expected to be read, and a class is held before or after the next lecture to incite and help the students. An examination takes place at the end of the course requiring a higher standard than the ordinary college examination, and not a lower one on account of the student's difficulties, for such students are allowed eventually to take a University degree, and it is correctly felt that it would be exceedingly mischievous in any way to lower the standard now required for that. This may seem a high one for candidates often consisting of a large proportion of working men, but nevertheless, in many cases where comparison could be made with young men resident at college, the former have proved to have the advantage over the latter. This again is not incredible ; persons attending these lectures are drawn from all classes alike, yet all are volunteers, who have felt their want and chosen their subject—the best soil for any seed of knowledge to fall upon. It is not the upper classes only who are found to appreciate higher education, but it has proved to be a cause which can rouse passionate effort among working men placed in the most unfavourable conditions.

The Universities thoroughly sympathise with the demand in these days for knowledge in the lines of science and of modern history. There is perfect freedom from holding up classics and ancient languages, and abstruse mathematics as the *summum bonum*. The principal supporters of the movement are clearly divided into favourers of science, and favourers of literature and art, and an effort is made to thoroughly meet either demand. Indeed, nothing is more striking in reading this publication than the elasticity with which the University sets itself to fit its syllabus of subjects, and its arrangements for teaching them, to the various wants of the different bodies who wish to avail themselves thereof—whether colleges, philosophical societies and institutes, free libraries, subscription libraries, or special societies or companies for the purpose. Instances are given of the lectures being carried on by all these various bodies, and to all who would make use of this means of increasing knowledge, practical advice is here given upon matters down to those of the smallest range, and we may quote the following experiences :—

Ladies more than gentlemen are glad of the educa-

[1] "The University Extension Movement." By R. G. Moulton, M.A. With an Introduction by Prof. Stuart, M.P. (London : Bemrose and Sons, 1886.)

tion here offered, and ladies accordingly should always form part of the committee; young people also who have lately left school and can attract their companions to continue whatever study they have liked or felt the value of; pupil teachers—often, hereafter we hope, as at Hull now, the School Board paying the fee—attending as a matter of business; and artisans who feel their deficiencies. The trades unions of the latter already, some of them, spend 1000*l*. a year in education, and if men can also be attracted here to increased knowledge, lay in a solid foundation of some science at a course of lectures, and get their intelligence awakened to what is going on in the world around them, public-houses will to them be no great temptation, and much of their work will be carried on more intelligently.

Where, as is generally the case, from three to five towns at no great distance apart can agree upon a course of lectures to be given, and audiences can be drawn to both afternoon and evening deliveries, it is found that the charge made to one of the courses need not exceed three shillings for the set of twelve lectures. Nevertheless the financial difficulty is described as the greatest both to lecturers with the rich University at their back, and to hearers, who certainly may lose working-hours and perhaps feel the attendant small expenses of books, &c. It is one of the most curious characteristics of this movement that the lectures are assiduously attended by all classes of society alike, and yet the seekers after knowledge themselves do not value it at its cost price, even when offered on so liberal and economical terms. However, higher education always did require the help of the patron of letters and of the founder of the college, and he who assists these classes may rest satisfied that he is carrying on their work in a modest way.

Prof. Stuart in his Introduction hopes, and cannot doubt, that the University or some other competent body may realise the vast influence and noble position here to be attained. The compressed population of England possesses great economical advantages over the scattered townships of America. It cannot be believed that financial difficulties will be suffered to stand in the way of this movement, and we may look forward to seeing our Universities literally worthy of their name through offering all knowledge to all sorts and conditions of men.

W. ODELL

THE NEW NATURAL HISTORY MUSEUM IN VIENNA

THE two magnificent palaces in the Ringstrasse, opposite the old Kaiserburg, designed, the one for the conservation and exhibition of the art history, the other of the natural history, collections of the Imperial Court, are rapidly approaching completion. Completely alike as they are in their decorations and their style of architecture generally, their interior arrangement does of course in each case conform with the special requirements of the collections each is intended to receive. The lateral front, 69·38 metres long, faces the Ringstrasse; the main fronts, at right angles to the Ringstrasse, run, with a length of 169 metres, parallel to each other, separated by a square which is laid out in garden plots, and is to be crowned in the centre by the monument of Maria Theresia. The design and execution of the two buildings emanate from one of the most eminent architects of Vienna, Karl Baron Hasenauer, who is at present directing likewise the erection of the Court Theatre, and the reconstruction of the Hofburg.

The building occupying the more western site, and destined to receive the Natural History Museum, is somewhat further advanced as a whole than its eastern compeer. A few particulars regarding this Institute will be acceptable to the readers of NATURE.

The collections hitherto kept apart, and now about to be united into one grand and indivisible whole in the new building, are under the supreme direction of the Royal and Imperial Chief Staff of Stewards of the Court (*Obersthofmeisteramt*), the present head of which, Prince Constantine Hohenlohe, takes a most lively interest in this branch of his administration. They embrace:—

(1) The Mineralogical Court Collection, hitherto distributed in four rooms of the Hofburg and some smaller underground compartments there. These comprise the mineralogical, geological, and palæontological treasures.

(2) The Zoological Court Museum, popularly known as the "Naturalien Cabinet," hitherto exhibited in a quarter of the Hofburg, in Josephsplatz, adjoining the Court library.

(3) The Botanical Court Museum, which, along with the herbarium of the University, found its accommodation in a structure situated in the Botanical Gardens, and belonging to the University.

(4) The Prehistoric, Anthropological, and Ethnographical collections, hitherto not exhibited, but kept packed in various depots.

The new building destined for the accommodation of these collections possesses four stories. The lowest, elevated but a few feet above the level of the street, and distinguished as the "*Tiefparterre*," is arranged as a storehouse, with assorting rooms for the different divisions of the Museum, and here, too, the chemical laboratory for the mineralogical department is to be fitted up. The next two stories, distinguished as the "*Hochparterre*" and "First Floor," are designed for the exhibition of the various objects that will be arranged for general view. Each of them consists of a suite of nineteen halls, ranging from 200 to 260 square metres in area, disposed all round the exterior face of the building, which stands on free and open ground, in such order that, entering from the staircase, visitors will be enabled to pass through them in a continuous series, re-issuing into the staircase at a place opposite to that by which they entered. Inside this exterior suite of rooms, and looking down into the two large courts, are ranged a series of smaller compartments in a line parallel to that of the large halls, destined in part likewise for purposes of exhibition, but mainly for the libraries of the different departments and the laboratories of the various divisions.

The plan for the distribution of the different collections in the halls, and for the general arrangement of the whole, was drawn up by my predecessor, Intendant Hofrath von Hochstetter, who, unhappily, was called away in the midst of his ardent activities in the summer of 1884; and, except in the case of a few quite subordinate alterations, this plan has been completely maintained.

The former Mineralogical Court Collection is divided into two assortments: a mineralogical-petrographical and a geological-palæontological. The first, which is under the care of the custodian, Dr. A. Brezina, assistant to Dr. Friedrich Berwerth, has the Halls I. to V. inclusive in the *Hochparterre* (see figure) assigned to it. In the central repositories of the Halls I. to III. will be shown the finest specimens of our long-celebrated collection of minerals, arranged in the main according to the system of Groth. The wall-cases, having higher frames, will exhibit in part the larger specimens, and in part local series of minerals. In the window recesses in Hall III. will be disposed a collection of polished precious stones.

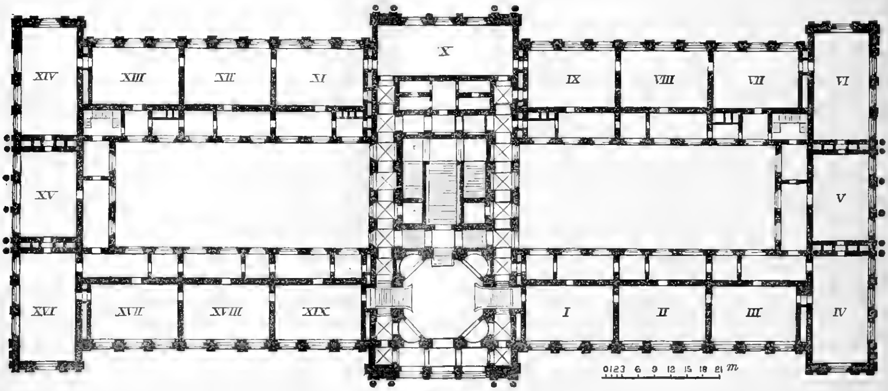
Hall IV. will display in its wall-repositories a collection representing the paragenetic relations of minerals, as also smelting processes.

The central cases of Hall V. are intended to accommodate the meteorites. These will constitute the most brilliant point in the whole division. According to the last inventory of Dr. Brezina ("Year-Book of the Royal and Imperial Geological Institute," 1885, p. 151), this collection, on May 1, 1885, represented no less than 358 localities in 1197 specimens, having a total weight of 1,134,836 grammes. The wall-repositories of this hall will contain the collection of stone species, as also the beautiful and instructive collection of building materials amassed by a voluntary fellow-labourer, Herr Felix Karrer.

The Halls VI. to X. are destined for the Geological Division. At the head of this department is Herr Theodor Fuchs, with his assistants, Herren E. Kittl and F. Wähner. In Hall VI. will be displayed the rich phyto-palæontological collection acquired for the Museum in largest part by purchase from Baron von Ettingshausen, and containing the types enumerated in his many descriptive works, a collection which has already been exhibited by himself. In the wall-repositories of this hall a collection of instructive specimens is to be presented, illustrating the dynamic processes in the formation and transformation of stones. The Halls VII. to IX. will present to view the collection of petrifactions classified, in the first place, according to the grand orders of the different ages and, within this classification, according to the zoological system. Hall X., finally, is destined for the exhibition of the skeletons of the larger Mammalia of the Cænozoic age, as also of the numerous and beautiful moa skeletons we possess.

The treasures of this last hall will enable the student to pass now, without break of continuity, into the prehistoric series of specimens under the direction of Herr F. J. Szombathy, with Herr N. Wang as his assistant. This collection will extend through the Halls XI. to XIII. Sorted into great groups, there will be displayed in these spaces the accumulations of the Palæolithic and Neolithic periods, the Bronze period, the Hallstätter period, the Latèn period, then of the Roman and Merovingian periods. Within these large groups the distribution will be of a geographical character, so that each locality will have its own treasures of the prehistoric age grouped by themselves. The most prominent section in this division will be formed by the excavations from the celebrated burying-field on the Hallstätter Salzberg, and hardly less interest will be excited by the disentombments from the caves of Moravia and Krain, from the settlements and burying-grounds in Carinthia, in Krain, in Northern Bohemia, &c.

The remaining spaces of the *Hochparterre* are allotted to the ethnographical collections under the supervision of the Custodian, Herr Franz Heger, with his assistant, Dr. M. Haberlandt. Here, too, the arrangement will be of a geographical nature, Halls XIV. and XV. being



assigned to the ethnography of America, Hall XVI. to that of Australia and Oceania, and Hall XVII. to that of Africa, while Halls XVIII. and XIX., along with some smaller adjoining compartments, will represent the ethnography of Asia. In this division, which will have all the charm of novelty for our Viennese public, the richest collections are those from Brazil, and, next to these, from the regions of the Upper White Nile.

In complete accordance with the structural arrangement of the *Hochparterre* is that of the "First Floor," in which the Halls XXI., XXII., and so on, will range themselves exactly above the Halls I., II., &c., the intermediate number of XX. being borne by the vestibule in the *Hochparterre*. The whole of this "First Floor" is devoted to the exhibition of the zoological collections. This division falls under the supervision of the Director, F. Steindachner, who has, in addition, specially reserved to himself the care of the collections of Fishes, Amphibia, and Reptiles. Other officials of this division are Herr A. von Pelzeln and Friedrich Kohl for the Mammalia and Birds; Profs. Brauer and Dr. E. Becher for the Mollusca; Herr A. Rogenhofer for the Lepidoptera, Hemiptera, and Hymenoptera; Herr L. Ganglbauer, for the Coleoptera and Orthoptera; Prof. F. Brauer, for the Diptera and Neuroptera; Herr C. Kölbl, for the Crustacea, Myriapoda, and Arachnida; Dr. G. von Marenzeller and Dr. von Lorenz, for the other divisions of the invertebrate animals.

Most richly represented in the zoological division are,—the group of birds, in respect of which, and more particularly the types from Brazil—thanks to the collections of Natterer, formed in his time—our Museum still, perhaps, takes the first rank among the Museums of Europe; the group of fishes, which recalls to mind the labours of a Heckel, a Kner, and recently our excellent Steindachner; the group of insects in general, and, in particular, that of the Diptera, in which are incorporated, among other collections, the celebrated ones of Meigen and Schiener, &c.

In Hall XXI. are exhibited the Protozoa, Cœlenterata, Echinodermata, and Vermes; in Hall XXII., the Arthropoda; in Hall XXIII., the Mollusca; in Halls XXIV. to XXVI., the Fishes; in Halls XXVII. and XXVIII., the Amphibia and Reptiles; in Hall XXIX., a special collection of the Birds of Austria-Hungary; in Halls XXX. to XXXIII., the systematic collection of Birds; and in Halls XXXIV. to XXXIX., the Mammalia.

In some adjoining rooms on this floor will be exhibited the very rich and magnificently prepared collection of fish skeletons presented to the Museum by the Director, Steindachner.

The highest story of all, the so-called "Second Floor," presents the same distribution of halls and adjoining rooms as do the *Hochparterre* and the "First Floor." The halls distinguished by the numbers from XLI. to LIX. correspond with the Halls I. to XIX. in our sketch.

The spaces on this floor will, as a rule, not be admissible to the public at large, but will be mostly appropriated as workrooms for the officials of the establishment and for experts to whom the use of the collections and other appliances is to be granted on the most favourable conditions possible.

One half of the second floor, comprising the halls from XLI. to XLIX. inclusive, will be set apart for the zoological division. Here the main collections of the invertebrate animals, only a small part of which can be exhibited on the first floor, will be kept in closed cases. Two halls will accommodate the skeletons of the Mammalia and birds, and one hall will lend itself as a library to the accommodation of periodical literature of general interest, while all publications of special departments will be distributed in the workrooms of the respective divisions.

Hall L. is destined for the collection, already very rich, of human skulls and skeletons.

Halls LI. to LIV., inclusive, are devoted to the botanical division. On the death, last summer, of the custodian of this department, Dr. Reichardt, the charge of it was committed to Dr. G. Beck, with whom is associated as assistant, Dr. Szyszylovic. The first three halls contain the herbarium, very valuable for the numerous original types it possesses; the last comprises the collections of woods, fruits, &c.

Halls LV. and LVI. form the reserve rooms for the geological division, in which the particularly rich chief collection of Tertiary Conchylia and the more subordinate collections of Foraminifera and Bryozoa are to be bestowed.

The Halls LVII. to LXIX., finally, are to be appropriated as reserve rooms for the ethnographical collection, which is growing at an extraordinarily rapid rate.

Be a few words still allowed me respecting the state of the works yet needing to be completed before our Museum can be opened for public entertainment and instruction.

The building of the palace and its decoration in all exterior parts is finished. All the halls, workrooms, and dwelling-rooms are ready for use and in large part already occupied. The cases and stand apparatus destined to receive the collections are also in large part already set up or in process of being set up. Building operations of any serious extent yet remaining to be done are confined to the interior, and more particularly the central axis of the building in which the staircase stands. This work, however, is of such compass that, according to the declaration of the superintendent of the building, it will yet claim nearly two years before it is ended. So far as the collections themselves are concerned, they are all, with the exception of the large Mammalia, already transferred into the new building, and a beginning has also been made in arranging and disposing them. With the final completion of the building, this latter work will likewise be completed, and then will this new establishment for scientific labour and for the instruction of the public be at once opened. FRANZ VON HAUER

Vienna

NOTES

THE Council of the Royal Meteorological Society have arranged to hold at 25, Great George Street, S.W., on the evenings of March 16 and 17 next, an exhibition of barometers. The Exhibition Committee invite co-operation, as they are anxious to obtain as large a collection as possible of such instruments. A list of some of the principal patterns of which the Committee desire specimens has been prepared, and may be had by applying to Mr. William Marriott, Assistant Secretary. The Committee will also be glad to show any new meteorological apparatus invented or first constructed since last March, as well as photographs and drawings possessing meteorological interest not previously exhibited.

THE appointment of Sir Lyon Playfair to be Vice-President of the Council will be welcomed by all friends of education and of science. Sir Lyon's recent utterances on the duty of the State as to the promotion of scientific research must be fresh in the memories of our readers; and it will be interesting to watch to what extent the Minister's practice accords with his creed.

THE inauguration of the statue of Claude Bernard by Guillaume took place on Sunday last, at the entrance of the Collège de France. Speeches were delivered by MM. Paul Bert, Berthelot, Chauveau, Dastre, Fremy, and Renan. The audience was large, in spite of the very cold weather. The statue of Bernard stands near a table on which has been placed a dog undergoing dissection. The animal is partly concealed by a large bronze sheet on which are written these words—"Glycogenie Diabete—Nerfs vaso-moteurs—Substances toniques—Liquides digestifs," which may be considered as giving a summary of the extent of Claude Bernard's disquisitions and discoveries.

THE death is announced of Dr. Arnold Konstantin Peter Franz von Lasaulx, Professor of Mineralogy and Geology at Bonn University. He died at Bonn on January 25, aged forty-six years.

AT the last sitting of the Paris Academy of Sciences M. Paul Bert took leave of his colleagues. He said that his academical qualifications were the principal cause of his appointment to his mission. He will be brought into contact with the *savants* of the East, and he is hoping to convert them to the principles of the West merely by persuasion and without being obliged to resort to coercion.

THE Académie des Sciences, in awarding the Prix Montyon to M. Girard, the director of the laboratory opened in Paris seven years ago for testing the quality of the food and drink sold by the tradesmen of the capital, has issued a report which shows how much good this laboratory has done. The laboratory was first opened in 1878, and specimens of wine, beer, cider, milk, chocolate, coffee, tea, &c., are examined daily; so, too, are the colours used for toys, sweetmeats, and liqueurs, as well as pork suspected of containing trichinosis, and tinned meats. Some of these samples are brought by the public, and the analysis is made free of cost when all that is asked is whether they are free from adulteration. If, however, an analysis of their proportionate composition is required, the laboaatory makes a small charge, and this brings in an annual income of about 1200*l.* a year. A larger number of samples are, however, brought in by the twenty inspectors who are attached to the laboratory, and whose duty it is to visit the different taverns and grocers' shops, and examine the articles offered for sale. These inspectors are provided with a microscope and with acids, which enable them to test a good deal of merchandise on the spot, and they only bring back to the laboratory specimens of the articles which they have reason to suspect are adulterated. There are twenty-five chemists attached to the laboratory, each of whom has his own special department, one taking milk, another wine, and so on. Each sample is divided into two parts, one of which is kept as evidence in case it should be found to be adulterated. The municipal laboratory analyses about 25,000 samples per annum at a cost of about 8000*l.*

THE total rainfall at the Ben Nevis Observatory during 1885 was 146·50 inches, the largest monthly fall being 24·33 inches in

December, and the least 4·97 inches. On December 12 there fell 5·34 inches, and on the following day 3·52 inches, or 8·86 inches on these two days.

AMONGST the objects which will be exhibited in the Ceylon Section of the forthcoming Indian and Colonial Exhibition will be a large ethnological collection from the Maldive Islands.

THE discovery of a portion of the vertebral column of a specimen of *Mosasaurus gracilis*, Ow., is announced to have been made in the hard white limestone or chalk of Whitewell, near Belfast.

DR. ARCHIBALD GEIKIE, Director-General of the Geological Survey, has now completed his "Class-Book of Geology," and the work will be published during next week by Messrs. Macmillan and Co. This volume completes the series of educational works on physical geography and geology projected by Dr. Geikie.

IT is interesting to note that the trout and salmon reared in February last year by the National Fish Culture Association have achieved the growth of 6½ inches, which is remarkable considering they have been subjected to an artificial existence. The whitefish hatched in 1885 have reached the size of 5 inches.

THE iris of the eye of Italians is most commonly chestnut; according to M. Mantegazza, the proportion of such is 64 per cent., the black eyes number 22 per cent., the blue 11, and the gray 3. Piedmont and Lombardy have the largest proportion of gray eyes; Venetia, of blue. In general the chestnut colour of hair amounts to 71 per cent.; then comes the black hair, 26 per cent.; then the blond, 3 per cent. (though in Venetia it is 8). Black hair is rare in Venetia. More than three-fourths of the Italians have abundant hair. Southern Italy excels Northern in this respect; in Tuscany the poor heads of hair preponderate (58 against 42 per cent.). As to beards, the colour does not always coincide with that of the locks. While chestnut preponderates, this preponderance is less marked; and one sometimes finds chestnut locks with blonde, and more often brown, beards. Bushy beards with abundant locks are most common in the South of Italy. In two-thirds of Italy, the natives wear the beard short or are clean shaven. This practice dominates especially in Tuscany (82 per cent.); the Sardinians have most long beards (50 per cent.). Red hair in Italy has been a subject of discussion among anthropologists; some think red-haired persons are remnants of a race almost extinct, and which extended to the banks of the Rhine and into England; others think red hair a mere physiological accident, from which no conclusion can be drawn. In Italy throughout one finds a few cases of red hair. In one commune, Sant' Agata di Puglia, red hair is predominant. No explanation has been given of the fact. Baldness is most common in Tuscany. In Italy generally, of 10,000 young men examined for military service 20 were rejected for premature baldness, and 52 for diseases of the scalp.

MR. CHARLES T. NEWTON, C.B., will on Tuesday next (February 16) give the first of three lectures at the Royal Institution on "The Unexhibited Portion of the Greek and Roman Sculptures in the British Museum" (illustrated by drawings and casts).

IT has been recently pointed out that the number of births in France per 10,000 inhabitants has diminished more than one-third in a century. It was 380 in 1771-80, 289 in 1831-40, and only 241 in 1871-80.

SEVERAL Continental geologists have been lately engaged in tracing the marks of the Ice Age on the Northern Alpine slopes. According to Dr. Brückner (in *Naturforscher*), the decrease of size in the diluvial ice-streams from west to east, corresponding to a decrease in the glaciers of the present, and due, no doubt, to the lowering of the region eastwards, is a noteworthy feature. Then it is becoming even more clear that there were at least two ice-periods, separated by a long interglacial period. The number of geological profiles containing two moraines (an older and a younger) deposited by glaciers, and separated by a layer which cannot have arisen under the ice, is considerable; in the region indicated nineteen such are known. The separating layer is in some cases loam (from weathering); in others it contains diluvial coal; in others it is formed of river deposits, &c. The position of these profiles shows that the ice-masses must have shrunk to the highest parts of the range after the first ice-period. The climate of that interval was probably much like the present; this is inferred from examination of the interglacial coal of Innsbruck, &c. The second glaciation was not so extensive as the first; for to the north of the moraines of the later glaciers appears a projecting strip, of more or less breadth, of the older moraines. This outer zone of moraine has also some special features in composition. In the interglacial period the rivers cut valleys in the masses deposited by the older glacier-streams; and these were filled again when the later glaciers came. Between the Rhine and the Traun there is evidence of a still earlier period of glaciation. Again, the coincidence of limits of the lake-region in the northern border of the Alps with those of the diluvial glaciers is significant. While some geologists attribute these lake-basins to erosion by glaciers, others think they were preglacial, and only prevented by the glaciers which occupied them in the Ice Age from being filled with earthy matter, &c. Dr. Brückner notes the fact that most of the geologists who have studied the features of the Bavarian lakes, take the former view, while those who have studied the Swiss lakes (where the relations are more complicated) take the latter.

THE London Stereoscopic Company's second annual International Amateur Photographic Exhibition, 1886, will be held at the Art Galleries, 103, New Bond Street, W., from April 15 to May 24.

THERE were (according to Dr. Dujardin-Beaumetz) 19 deaths from hydrophobia in Paris last year—a number higher than in previous years; and yet the number of stray dogs destroyed was also higher (viz. 5060). Of these 19 persons, 15 were males and 4 females. The youngest was a little girl of 5½ years; the oldest, a man of 63. The time of incubation varied from 19 months (in the case of a young man of 26) to 29 days (a child of 11). In only one case was the time of the bite unknown. Excluding that, and the exceptional case of 19 months, an average of about 2 months is arrived at for the time of incubation. As to duration of the disease, the extreme limits were 1 day and 8 days; average 3½ days. In no case were the lower limbs bitten. In 12 cases out of 18, the upper members were bitten, especially the hand (9 times out of 12), the wrist twice; in the 6 other cases it was the face (5 times) and the skull (once) that were attacked. Lastly, in 17 cases of the 18, the bite was that of a dog; in the remaining case, it was that of a cat. It will be noted that these statistics relate only to *deaths* from hydrophobia.

FERMENTATION can be utilised (as was shown by Roberts in 1861) for quantitative determination of sugar in urine. The method has been recently developed by Herr Einhorn (*Virchow's Archiv*), and he claims that the test will indicate one-tenth per cent., or even, if the fermenting liquid be previously boiled ten minutes, one-twentieth per cent. of sugar (the common reduction and polarisation-tests are exact to about 3 per cent.). Herr Einhorn uses three tubes of special shape: one with normal urine having no sugar, another with the urine to be examined, and the third with urine having sugar added to it. The urine, whether containing sugar, or normal, is boiled and diluted with boiled water to the amount of the original volume. Compressed yeast is added to the liquid in the proportion 10 per cent. Acetic acid is of no use for the fermentation, and may be prejudicial.

A SWEDISH naturalist has collected some remarkable statistics of the important part natural history and certain other branches of science have played in the names assumed by the Swedish nobility when elevated to that rank. As regards zoology, five names begin with Lejon (lion), and six with the German equivalent Löwen, Lewen, or Len. Only one name begins with Örn (eagle), but six with the German form, Adler. The mythical animals Grip (griffin) and Drake (dragon) have been appropriated by six and three families respectively. Of other animals and birds of prey, Tiger (tiger) is represented by four families, Ulf (wolf) by three, Björn (bear) by three, Falk (falcon) by three, Geijer (hawk) by two, and Räf (fox) by one. There are, further, two families whose names begin with Oxe (ox), one with Häst (horse), two with Elg (elk), one with Hjort (stag), one with Rålamb (doe), one with Get (goat), one with Svin (swine), one with Bäfver (beaver), one with Dufva (dove), one with Reiher (heron), one with Stork, one with Gädda (pike), three with Rud (carp), one with Ödla (lizard), and one with Brämo (gadfly). Many more names have been taken from trees and plants. Thus, fourteen begin with Lilje (lily) and Ros (rose) respectively, eleven with Lager (laurel), nine with Ceder (cedar), seven with Ek (oak), six with Lind (lime), and so on. If we turn to astronomy, numerous stars form the prefixes of names, but in no case the sun or the moon. Fourteen begin, and eleven end, with Stjerna (star). It is mentioned that the famous name, Oxenstjerna, is a corruption of the German word Stirn (forehead), which is proved by the family escutcheon, and is not derived from the above word.

A CORRESPONDENT gives some interesting particulars to a Norwegian journal of the habits of herring jumping out of the water when frightened. He states that he has observed whole shoals of this fish, in their anxiety to escape when pursued by whales, piled up above the surface of the sea to a height of from three to six feet. On one occasion the fish formed a mass even with the top of the mast of a fishing-boat, viz. about fifteen feet, and had part of the same fallen into the boat it would doubtless have sunk.

THE following are the results of a very elaborate mathematical inquiry which Prof. N. Joukowsky has recently made into the laws of motion of a solid body having hollows filled up with a homogeneous liquid. Various shapes of hollows filled with liquid have been considered, as also the case of a vortex-motion of the liquid having interior friction. Some phenomena of the interior motion of the liquid itself, in the case of the solid body when caused to rotate, were verified by experiments which proved conformable to the theory; they have shown that in a body whose rotation-velocity is decreasing from its surface to its centre (*e.g.* a glass sphere filled with water, and which is brought into motion), the molecules flow from the poles to the equator, and *vice versâ* where, the rotation being suddenly stopped, the speed of rotation is on the decrease from the centre to the circumference. The general conclusion of the inquiry is, that if we have a hollow body filled with a liquid, and this system be brought into motion, its motion will tend to reach a limit characterised by one of the chief axes of inertia of the body taking the direction of the chief momentum of the communicated motion, and the whole system will rotate around this axis as a single body—the speed of rotation being constant, and equal to the quotient obtained from the division of the force applied by the momentum of inertia of the system with regard to this axis. M. Joukowsky asks,—Does it not explain the circumstance that our planets, notwithstanding the variety of their occasional primary velocities, all rotate around their axes of inertia?

IT is stated in Paris that the telegraph now extends to Langson in Tonquin, on the Chinese border. As already mentioned in NATURE, on the Chinese side the telegraph was carried during the recent military operations in Tonquin from Canton to Lungchow, about thirty miles from Langson. Hence, with the exception of this short gap of thirty miles, the telegraph extends in an unbroken line from Saigon in the south of the Indo-Chinese peninsula to Pekin, where five years ago there was no telegraph whatever. The rapidity with which, since 1881, it has spread all over China, and has come into general use, is one of the wonders of modern days.

THE "binding" effect of intense cold and a fierce wind on snow is remarkably illustrated by a photograph, in *Science*, of a large mass of snow formed on one side of a telegraph pole (at the top) near the summit of Mount Washington. Lieut. Schwatka notes this in relation to the building of snow houses by the Eskimo. While the cohesion of snow in our latitudes (and the early Arctic snow) is of a plastic, wet, or "pasty" nature, the snow used in building, packed by high wind and cold, is dry and almost stone-like. Cutting a thin portion gives a shower of fine powder as from loaf-sugar. Blocks of this snow ring like a well-burnt brick, or a bar of suspended steel struck with the hand. Lieut. Schwatka remembers a block rolling down hill 15 or 20 feet, and says, "I doubt if a rolling guitar would have given forth many more confused musical tones than the bumping block as it struck and bounded down the hard stone-like bank of snow." The least quantity of ice in the snow, however, makes it more or less worthless for building. To produce this snow, it may not be necessary that the wind and the low temperature have occurred together, but both must have happened before the Eskimo will use the snow for building.

A STRONG shock of earthquake took place in the Island of Lemnos in the night of January 17-18. There was no subterranean noise.

AN earthquake is reported from Jaska and Samobor (Croatia) on January 23. Two violent shocks were felt at 9.35 a.m. on that day. No considerable damage was done, although many walls show fissures.

AN International Exhibition will be held at Madrid in 1888.

THE Calcutta Correspondent of the *Times* telegraphs, under date the 7th inst., that Mr. Ney Elias, the new British Consul to Kashgar, has made a successful journey down the Upper Oxus, through Shignan and Koshan, to Badakshan. He was everywhere well received.

THE Calcutta *Englishman* states that, shortly after the last cyclone suddenly burst over Madras, the local Government wrote to the Government of India, suggesting that telegraphic communication should be established between Madras and either Sumatra or the Nicobars for the despatch of storm-warnings. The Indian Government, however, considers that the value of meteorological stations in these localities in relation to the Storm Signal Service on the Madras coast is by no means established. Experience has shown that the storms which reach Madras are in most cases formed on the east or the north-east coast of Ceylon, and that therefore telegrams from the opposite side of the bay would give little or no help in forecasting the approach of storms. The Government of India, therefore, suggests that the telegraphic reports from Pondicherry and Negapatam, as well as from Jaffna and Trincomalee in Ceylon, would be more likely to give the required information.

A REMARKABLY strong Artesian spring has been struck, at a depth of 155 feet below the surface, at Alnwick, in a boring which the Local Board are having sunk for the supply of the town. This spring, which was met with in a bed of sandstone, rises to no less than 30 feet above the surface, and is flowing with increasing volume at the rate of 115,000 gallons per diem. The site of this boring is at an elevation of some 200 feet above the level of the town, from which it is about two miles distant

THE additions to the Zoological Society's Gardens during the past week include two Maholi Galagos (*Galago maholi*) from West Africa, presented by Mrs. Max Michaelis; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Corbet; an Indian Otter (*Lutra nair* ♂) from Ceylon, presented by Capt. J. C. Withers; a Ring-tailed Coati (*Nasua rufa* ♂) from South America, presented by Lieut. J. H. N. Theed, R.N.; a Red-bellied Waxbill (*Estrelda rubriventris*) from West Africa, presented by Mrs. T. Johnson; two Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. F. J. Dawe; a Malbrouck Monkey (*Cercopithecus cynosurus* ♀) from West Africa, two —— Lemurs (*Lemur* —— ♂ ♂) from Madagascar, a Common Boa (*Boa constrictor*), an Anaconda (*Eunectes murinus*) from South America, deposited; a Great Kangaroo (*Macropus giganteus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE DOUBLE-STAR 61 CYGNI.—The determination of the orbit of this double-star has hitherto baffled those astronomers who have attempted to deduce it from the numerous measures which have been made. Thus one computer finds the relative motion of the components to be rectilinear, another hyperbolic, and another circular, but in no case have the determinations been altogether satisfactory. Recently, however, Dr. C. W. Peters, of Kiel, has succeeded in obtaining elliptic elements, with a periodic time of 782·6 years and angle of eccentricity = 10°, which appear to represent the great mass of observations which have been made from the earliest times down to 1883, with considerable accuracy. Herr Peters has computed the following ephemeris from his elements:—

Epoch	1885·0	1886·0	1887·0	1888·0
Position	119° 44′	120° 7′	120° 31′	120° 55′
Distance	20″·60	20″·71	20″·81	20″·92

Taking the parallax of 61 Cygni to be 0″·45, it appears from these elements that the combined mass of the system is about one-half of the sun's mass, whilst the mean distance between the components is about 70 times that of the earth from the sun.

THE ZODIACAL LIGHT.—In October 1883 Prof. Arthur Searle presented to the American Academy of Arts and Sciences a very valuable paper on the zodiacal light, in which he had collected and reduced on a uniform system the evening observations of all the principal observers. The principal points then brought out were that in all probability the apparent changes in the latitude of the zodiacal light were due mainly, if not entirely, to the effect of atmospheric absorption, and that the method of observation by drawing outlines must be replaced by careful photometric observations if definite knowledge was to be substituted for the vague information we now possessed as to the "Gegenschein," the "zodiacal bands," &c.; and Prof. Searle concluded with the suggestion that the ordinary meteoric theory would gain greatly in simplicity by the substitution of meteoric dust scattered generally throughout the solar system for the meteoric rings that have been usually imagined. Prof. Searle has continued his investigations in a recent memoir, in which he corrects, for the effect of atmospheric absorption, Jones's observations of what the latter called the "stronger light" at the elongation 60°, whether made in the morning or evening. The result of the inquiry is to confirm the view arrived at previously, that atmospheric absorption largely affects the apparent position of the zodiacal light, and Prof. Searle again lays stress on the need for photometric observations. Prof. Searle concludes that, after correcting for atmospheric absorption, there seems reason to think that the zodical light has had, during the present half-century, a more northern latitude near the longitude 180° than near the longitude 0°. He also shows, from a careful study of the distribution of the stars in the *Durchmusterung*, that "upon the meteoric theory of the zodiacal light it is to be expected that a continuous zodiacal band should be present; but the question of its actual visibility is complicated by the slight maxima of stellar density which are situated along those parts of the ecliptic most readily accessible to observation from stations in the northern hemisphere." An interesting result is obtained from an examination of the elements of the 237 asteroids first discovered, from which it would seem that "the belt of sky occupied by the projections of the orbits of" these asteroids "presents certain peculiarities which correspond to those of the zodiacal light, and suggest the hypothesis that the light may be partly due to minute objects circulating in orbits like those of the smaller planets."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 FEBRUARY 14-20

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 14

Sun rises, 7h. 18m.; souths, 12h. 14m. 23·7s.; sets, 17h. 11m.; decl. on meridian, 12° 56′ S.: Sidereal Time at Sunset, 2h. 50m.

Moon (Full on February 18) rises, 12h. 34m.; souths, 20h. 27m.; sets, 4h. 21m.*; decl. on meridian, 18° 22′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	7 15	11 46	16 17	17 29 S.
Venus	6 39	12 29	18 19	2 51 S.
Mars	19 27*	2 4	8 41	6 32 N.
Jupiter	20 44*	2 45	8 46	0 37 S.
Saturn	12 17	20 28	4 39*	22 43 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

Feb.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
14	111 Tauri	5½	1 51	2 34	164 273
14	117 Tauri	6	3 10	3 59	130 297
18	ξ Leonis	6	2 19	3 21	95 296
19	48 Leonis	6	3 44	4 43	87 301
20	τ Leonis	5	1 5	2 0	23 293
20	13 Virginis	6	21 36	22 23	72 176

Feb.	h.	
18	19	Venus at inferior conjunction with the Sun.
19	4	Mercury in conjunction with and 11° 22′ south of Venus.

Variable-Stars

Star	R.A.	Decl.		h. m.
	h. m.	° ′		
U Cephei	0 52·2	81 16 N.	Feb. 16,	21 58 *m*
λ Tauri	3 54·4	12 10 N.	,, 14,	22 43 *m*
			,, 18,	21 35 *m*
W Virginis	13 20·2	2 47 S.	,, 17,	0 0 *m*
δ Libræ	14 54·9	8 4 S.	,, 18,	23 28 *m*
U Coronæ	15 13·6	32 4 N.	,, 20,	0 48 *m*
U Ophiuchi	17 10·8	1 20 N.	,, 16,	3 9 *m*
			and at intervals of	20 8
β Lyræ	18 45·9	33 14 N.	Feb. 14,	14 30 *m*
			,, 17,	7 0 *M*
δ Cephei	22 24·9	57 50 N.	,, 14,	21 30 *M*

M signifies maximum; *m* minimum.

CHEMICAL NOTES

WE have already mentioned M. Konovaloff's researches into contact actions, published in the *Journal* of the Russian Chemical Society (1885, vii. and viii.) The following conclusions of his inquiry are worthy of being noticed:—The capacity of solid bodies for condensing gases on their surfaces is generally recognised, but their capacity of dissociating them under certain conditions must also be recognised now as a property of all solid bodies, although shared in by them in different degrees. Platinum enjoys this property to a high degree, but also many other solid bodies, glass among them, the intensity of its contact action obviously depending upon several circumstances: its chemical composition, the structure of its surface, and its temperature, as also upon the density of the gas it is brought in contact with. It being so, it appears possible, in the author's opinion, that in the dissociation phenomena studied by Sainte-Claire Deville (and having so great an importance for the theoretical discussions upon the dynamics of chemical reactions), the dissociation observed was a consequence of the contact action of the solid body. Contact action seems also to have played its part in the researches of M. Lemoine on the dissociation of hydrogen iodide. On the whole, in all those cases where the process of chemical transformation in a gaseous medium offers an uninterrupted character, there is reason to suppose that a contact action has been taking place. But if this supposition proved to be correct, we should be compelled to admit that the chemical transformation, even in its simplest shape in a gaseous medium, is intimately connected with the action of molecular forces—that is, with such actions which do not have the characters of determinated chemical combinations. Molecular forces ought to be taken into account even in the transformations going on in a gaseous medium ; both factors—tbe chemical affinity and the cohesion—appear so intimately connected that it would be impossible to delimitate them : the chemical reaction would appear as a result of both the forces which unite atoms in molecules and those which are at work between the molecules.

THE last issue of the *Journal* of the Russian Chemical Society (xvii. 7) contains the first part of a most valuable inquiry, by M. Konovaloff, into the part played by contact actions in dissociation. Without undertaking to deal with this immense subject in full, the author, taking advantage of observations he had made together with Prof. Menschutkin during their experiments as to the dissociation of compound ethers, has submitted to a closer investigation the contact phenomena when gases are brought into contact with solids. The want of cohesion between the gaseous molecules, and the great difference of densities of both the gas and the solid, give better conditions under which to study the influence of the solid. Summing up the researches of Sainte-Claire Deville, Würtz, Faraday, Ramsay, Berthelot, and many others who have devoted attention to the subject, the author shows that capillary structure and porosity are not necessary conditions in a solid body for producing dissociation ; smooth surfaces may also condense vapours and gases, and sometimes retain them with such a force as to make the disengagement of the absorbed gas quite correspond to the dissociation of a chemical compound. The character of the surface, having of course a great importance, M. Konovaloff has carried on his experiments so as to study the influence of the character of the surface. The first part of his inquiry contains the experiments made as to the dissociation of the tertiary amylacetate, the method of inquiry being successive determinations of the density of its vapours on W. Meyer's method. The result arrived at is obviously that the structure of the surface of the glass which is brought into contact with amylacetate vapours is of great importance ; but it is worthy of notice that the rough surface of the glass-powder condenses the vapour without producing a notable dissociation, while the smooth surface cf the glass-cotton dissociates it.

THE INSTITUTION OF MECHANICAL ENGINEERS

THIS Institution held its annual meeting at the theatre of the Institution of Civil Engineers on Thursday and Friday last under the presidency of Mr. Jeremiah Head, who was re-elected for the ensuing year.

A paper was read by Mr. J. H. Wicksteed descriptive of an autographic test-recording apparatus of a very ingenious character. It is designed to obviate both the labour of observation and that of hand-plotting. But, beside the saving of time and labour, there is the further gain, in obtaining the diagrams autographically, that the progress of the test is continuous ; and as time is a factor in the behaviour of a test-piece, it is important in making tests for comparison that there should be no irregularity in this factor.

The sample is held between an upper and lower gripping-box. The upper box is suspended from the back centre of a steelyard, which, by the adjustment of its poise-weight, weighs whatever pull is put upon the sample. The lower box is connected with a hydraulic cylinder, which puts the pull upon the sample, and extends it until it breaks. Thus while the hydraulic cylinder is doing the mechanical work of breaking the sample, the steelyard is measuring the load it sustains. The object of the indicator is to record simultaneously the amount of the load and the extension due to it. To get this simultaneous record the horizontal ram of the indicator, which carries the tracing pencil, is in fluid connection with the hydraulic cylinder which puts the load upon the sample, and the indicator therefore partakes of that load. Round the outer end of the ram is coiled a spiral spring, which is compressed as the pressure on the ram increases, and expands as the fluid pressure on the ram decreases ; the pencil records the point of equilibrium between the two. The friction of the leathers in the hydraulic cylinder and that of the indicator ram are both eliminated from the diagram, the first by putting on to the piston of the hydraulic cylinder a gross pressure equal to the effective pressure on the sample and the friction of the hydraulic leathers, and the second by revolving the indicator ram by belt power and gearing ; the driving power being applied in a plane at right angles to the longitudinal travel of the ram has no effect upon that travel, but entirely overcomes the obstruction which the friction of the leather would otherwise offer to the free travel of the ram, so that the ram becomes sensitive enough to respond to the very smallest want of balance between the opposite forces of the water pressure and the spring. For recording the extension of the sample simultaneously with the load upon it, the metallic paper on which the pencil travels is mounted on a brass barrel like that of an ordinary steam indicator ; and in accordance with the extension of the sample the barrel is made to revolve by means of an arrangement which eliminates any general movement of the sample, recording that only which is due to its extension.

The author summarises the autobiography of every specimen strained to the breaking-point in the testing machine. Entering the machine in a state of internal equilibrium, its first stage is what is called in the paper one of unyielding elasticity ; it extends about 1/10,000 of its length per ton of load, but on removal of the load remains unstrained. In its second stage the strains and stresses fluctuate, the bar yielding about 2 per cent. of its length, the strain being beyond recovery. The pencil of the indicator hesitates and almost trembles. There would seem to be a succession of local extensions in the bar, as was lately pointed out by Prof. Kennedy in this journal (NATURE, vol. xxxi. p. 504). These local extensions reduce the area locally in a higher ratio than the cohesive force increases ; fracture would at once occur were it not that after a short critical interval the bar sets up increased resistance, thus entering its third stage. Stable equilibrium is restored, but the permanent strain increases in its ratio with every additional ton, and the bar may stretch 20 per cent. During the last stage the equilibrium is again unstable ; the pencil steadily records a rapidly-decreasing resistance, accompanied by a local strain which, over the part where it occurs, is very much greater than in any preceding stage. The author concludes by drawing attention to the circumstance that the apparatus records definitely the elastic limit of the material, the diagram traced gives the gross mechanical work put upon the sample, as it enables the local extension about the breaking-point to be separated from the general, thus affording a means of comparing samples of different shapes ; and lastly the apparatus makes its record quite independently of the manipulation of the poise upon the steelyard.

A paper descriptive of tensile tests of iron and steel bars was read, prepared by the late Mr. Peter D. Bennett. His principal object in making these tests was to ascertain the relative effect produced on the tensile strength of a flat bar of iron or mild steel : (1) by a hole drilled out of the bar to the required size ; (2) by a hole punched $\frac{1}{8}$ inch smaller in diameter, and then drilled out to the size of the first hole ; and (3) by a hole punched in the bar to the size of the drilled hole. In each of the former cases the average strength was increased per square inch of the original area across the fracture ; in the third case there was a falling off in strength of nearly 20 per cent. owing to the method of perforation. The results in the first two cases were alike both for iron and mild steel, but in the third case the diminution in strength of mild steel was only 6 per cent. In another series of tests the perforated hole was filled with a rivet put in by a hydraulic machine with a pressure of thirty-one tons on the head, the results being relatively as before. The author considers these results to be due to the fact that in the drilled bar the slightly greater strain indicated was reached only along the transverse diameter of the hole, and that the strain on the metal decreased along the longitudinal diameter of the hole until it was distributed over the whole width of the bar. Thus, at the point where it was most severely strained the metal would receive some support from the less severely strained parts adjoining.

The tests go to prove that the elongation of different test-bars, all of the same length, is greatly affected by their diameter, those of larger diameter elongating more than those of smaller diameter, and that as the specimens decrease in length the contraction of area at the point of fracture decreases also; and, in consequence, the tensile strength increases when reckoned on the original area, and decreases when reckoned on the fractured area. The elongation in percentage of the original length is also very much increased in the shorter specimens, owing to the fact that the greater part of the elongation then takes place much nearer to the point of fracture, instead of being more equally distributed, as it is along the length of the longer bars.

A paper was read by Mr. A. A. Langley, descriptive of a hydraulic buffer-stop for railways, the chief advantages of which are absence of recoil after collision, continuous uniform resistance for bringing a train to rest, and absence of shock or breakage either in train or in buffer. The chief feature is the application of hydraulic resistance by the use of pistons working in horizontal cylinders filled with water, and fixed in line with the buffers of the rolling-stock.

THE VALUE OF THE REFRACTION GONIOMETER IN CHEMICAL WORK[1]

IMPORTANT advances in chemistry have often been the result of new methods of research, and these have generally involved the use of new apparatus. The introduction of the balance made the greatest of revolutions in chemistry; but the thermometer, the blowpipe, the polariscope, and the spectroscope in its multifarious applications may also be cited as examples.

My object is to speak of the refraction goniometer or spectrometer, by which the refraction and dispersion of bodies can be measured. The construction of this instrument, and the use of it, which ought to be a part of the regular training of chemical students, may be learned from many works on physics, but it is very fully described in Glazebrook's "Optics," together with the manner in which the angular measurements are reduced to refractive indices. By means of this instrument the index of refraction is easily obtained for liquid bodies; solids or gases require a more complicated apparatus, but those of them which can be readily dissolved in any liquid can be determined from their solutions.

The index of refraction (μ) of a body is a definite physical property, like its boiling-point, specific gravity, or solubility, and ought to form part of our knowledge of any substance. I have generally determined it for the line A of the spectrum of the sun; but Continental observers have usually adopted the red line of hydrogen, which is coincident with the solar line C.

The length of the spectrum—that is, the difference between the indices of refraction of extreme rays, say the lines H and A, which may be taken as the measure of dispersion—is another physical property, and an equally important one.

If the index of refraction and the dispersion of a substance be accurately known, we have a double test of the purity of any specimen that may have to be examined.

As, however, the refraction varies with temperature and other circumstances, it is better to deal with the specific refraction, that is, the index, minus unity, divided by the density $\left(\frac{\mu - 1}{d}\right)$. This is little, if at all, affected by pressure, heat, change of aggregate condition, mixture, solution, or, generally speaking, by chemical combination. Thus the specific refraction of water under different circumstances has been determined as follows, the observations being reduced for the line A of the spectrum:—

Water	Specific refraction
Liquid, at 1° C.	0·329
,, at 48° C.	0·329
Solid	0·331 [2]
Gas	0·324
Mixture with alcohol	0·330 [3]
Water of crystallisation	0·330 [4]
,, ,,	0·327 [5]

The identity of the specific refraction of a body in the solid state or in solution has been frequently proved; the last instances determined were as follows, the observations on the crystals being made by M. Soret, and on the solutions by myself:—

Substance	Solution	Crystallisation
Ammonia alum	0·2780	0·2784
Soda alum	0·2613	0·2604

For the purpose of calculation, however, it is more convenient to adopt what Landolt denominated the refraction equivalent, that is, the specific refraction multiplied by the atomic weight $\left(P\frac{\mu - 1}{d}\right)$. The refraction equivalent of water may be taken, therefore, as $0·3295 \times 18 = 5·93$. Of this, the two atoms of hydrogen may be assumed from observations on other bodies to represent 2·6, leaving for the atom of oxygen 3·33.

The specific refraction and dispersion of a body not merely gives an indication as to its purity or otherwise, but tells the quantity of the substance with which it may be mixed, if that substance is known. Thus Landolt has applied it to the quantitative analysis of mixtures, and gives examples, such as ethyl alcohol and fousel oil, ethyl alcohol and ether. I have applied it myself in the estimation of carbolic acid in disinfecting powders, by dissolving the acid out in a known quantity of alcohol, and determining the refraction and density of the solution.

In chemical investigations among organic compounds the determination of the specific refraction of the products is very valuable. Thus, in a recent investigation on the action of the copper-zinc couple on bromide of benzyl by Mr. Tribe and myself, there were three different ways in which it led us to results which we should not otherwise have arrived at.

(1) The viscid mass which resulted from the action appeared very unpromising, but, on examining it with the prism, its specific refraction and dispersion were so high that we determined to purify it, and this led to the discovery of the new hydrocarbon benzylene.

(2) When the reaction was performed in the presence of alcohol, it seemed probable that toluene would be produced; but the liquid, when heated, distilled off at 78°, which is the boiling-point of pure alcohol. Instead, however, of throwing the distillate away, it was examined in a hollow prism, and seen at once to be something very different. Indeed, the increased refraction and dispersion led to the belief that one-fifth of it was toluene, though that boils at 110°. On adding water, a liquid separated, which was proved to be toluene by its boiling-point and density, as well as by its specific refraction and dispersion, 0·5604 and 0·0474, agreeing sufficiently well with the known figures.

(3) On another occasion, among products of fractional distillation was a liquid which had too small a refraction to allow of its being considered a hydrocarbon. It was suspected that the low refraction might be due to oxygen or bromine; and this led to a further examination and the discovery that the liquid contained a new bromine compound.

But another important application of these physical properties is to the elucidation of the chemical structure of various bodies. A very large amount of information as to specific refraction is now at our disposal through the labours of different experimenters, not only in this country, but in Germany, Italy, Russia, Holland, and Sweden; and the whole course of recent investigations goes to show (1) that the specific refraction of a body depends essentially on its ultimate atomic constitution; but (2) that this is modified in certain definite ways by the molecular arrangement or structure. Thus, to take an instance: sugar, $C_{12}H_{22}O_{11}$, whether crystallised or dissolved, has the refraction equivalent of 119·3. If, however, we take each atom of carbon at 5·0, and water at 5·93, we should obtain the figure 125·1 as the calculated value. The discrepancy is far too great to be attributed to errors of experiment, and points to the fact that sugar is not, strictly speaking, a carbohydrate; that really it does not contain water, but that the hydrogen and oxygen are otherwise arranged, as chemists have concluded on other grounds. The oxygen in all hydroxyl compounds is 2·8, according to Brühl, and this would give for sugar the theoretical value 119·5, which is almost identical with the experimental number.

In a similar way it has been very fully substantiated that carbon, whenever it is in the condition which is termed "double-linked," has the value, not of 5·0, but of about 6·1. Hence in any compound the constitution of which is doubtful, we can tell how many carbon atoms are in this condition. Thus, to take terpene, $C_{10}H_{16}$. This has been the subject of much discussion among chemists, one considering it to have one pair of carbon

[1] Communicated to Section B of the British Association, at the Aberdeen meeting, September 1885.
[2] Rausch.
[3] Landolt; mean of three observations.
[4] In ammonia alum; Charles Soret.
[5] In double sulphates; Topsoe and Christiansen.

atoms double-linked, others two pair, and another as many as three pair. On these three suppositions its refraction equivalent would be 73·0, 75·2, and 77·4 respectively. Now the various isomeric terpenes have a refraction equivalent of about 72·9, leading to the belief that only one pair of carbon atoms is in that condition. This conclusion is enforced by the specific dispersion, which averages 0·0299. From the analogy of other compounds containing ten atoms of carbon and which are of known constitution, about this amount of dispersion might be expected to occur in a $C_{10}H_{16}$ having one pair of carbon atoms double-linked.

I do not know how far chemists may be disposed to accept these optical properties as the arbiter between rival theories of constitution; but their value as helps will not be denied.

With reference to this mode of experimenting, it should be borne in mind that a very small quantity of a substance suffices for the purpose of observation; and whereas chemical processes use up material, the refraction of a liquid can be taken with no other loss than the small amount which unavoidably clings to the vessels employed. This even may be recovered if it is worth the trouble.

A table of the approximate refraction equivalents of forty-six of the elements was drawn up for my paper in the *Phil. Trans.* of 1869. Many of these have since been re-determined, either by myself or other observers, and a new edition of the table was prepared for the Montreal Meeting of the British Association, and appears in the *American Journal of Science* of January 1885. Carbon, oxygen, nitrogen, sulphur, phosphorus, iron, chromium, silicon, and doubtless other elements have two or three different values; and the special circumstances under which these different effects upon the rays of light occur offers a most promising field for any future investigator.

J. H. GLADSTONE

THE RAINFALL OF THE BRITISH ISLANDS[1]

CLIMATE may be defined as that peculiar state of the atmosphere in regard to heat, moisture, and rainfall which prevails in any particular place, together with its meteorological conditions generally, in so far as these influence animal and vegetable life. The diversified characters which climate displays may be referred chiefly to the combined operation of these four different causes, viz., distance from the equator, height above the sea, distance from the sea, and prevailing winds.

The greatest differences, however, in the local climates of places situated at no great distance from each other arise from differences in the rainfall. The arid plains of the North-Western Provinces of India as compared with the fertile higher slopes of the Himalayas contiguous to them, and the widely contrasted climates of the western and eastern slopes of Scandinavia respectively, may be cited as illustrations. In the British Islands there are perhaps no stronger contrasts of climate than those pre ented by Skye and the Laigh of Moray. The mean temperature of these two regions in no month of the year differ so much as two degrees, and for several of the months they are nearly identical. But the rainfall of Skye rises towards, and in many places exceeds, 100 inches annually, whereas over the Laigh of Moray it is only about 26 inches. Now it is this difference in the rainfall, with the clear skies and strong sunshine that accompany it, which on the one hand renders the south shores of the Moray Firth one of the earliest and finest grain-producing districts of Scotland; and, on the other, renders the island of Skye quite unsuitable for the remunerative cultivation of cereal crops. It is this aspect of the rainfall which gives it so paramount a place in the climatology of a country.

Of all meteorological data, the rainfall is the most difficult to represent cartographically; and there is no other way to arrive at even a tolerable approximation to the average rainfall of a district than by numerous rain-observing stations well distributed over its surface. Hence in this inquiry all available statistics of the rainfall for the period of years selected have been used,—the number of stations being 1080 in England and Wales, 547 in Scotland, and 213 in Ireland—in all, 1840 stations. Notwithstanding this comparatively large number of rain-gauges, very extensive districts remain wholly, or all but wholly, unrepresented.

The period selected for the investigation is the twenty-four years ending 1883, and the principal sources from which the information has been obtained are the returns published by the Meteorological Societies of England and Scotland and by Mr. Symons. For the method of discussing the results we refer to the recently published Part of the *Transactions* of the Scottish Meteorological Society, pp. 131-33. It may be here enough to say that the whole of the averages have been calculated for, or reduced to, the same term of twenty-four years beginning with 1860 and ending with 1883.

The 1840 averages were then transferred to large maps of England, Scotland, and Ireland, and from the results thus shown the British Islands were shaded into six divisions, these shadings showing the districts where the mean annual rainfall

1st does not amount to 25 inches
2nd is from 25 to 30 ,,
3rd ,, 30 ,, 40 ,,
4th ,, 40 ,, 60 ,,
5th ,, 60 ,, 80 ,, and
6th above 80 inches.

On the map exhibited on the wall these divisions are shown by three tints of blue and three of red,—the blue showing a rainfall exceeding forty inches annually, and the deepest tinted blue the regions of largest rainfall; and the red a rainfall less than 40 inches, the lightest tint marking off those parts of England where the rainfall is least, or where it is less than 25 inches annually.

The regions of heaviest rainfall, marked off by 80 inches annually, or upwards, are these four:—

(1) The greater part of Skye, and a large portion of the mainland to the south-east, as far as Luss.

(2) The greater part of the Lake District.

(3) A longish strip including the more mountainous portion of North Wales, and

(4) The mountainous district of the south-east of Wales.

The rainfall is also heavy on Dartmoor, and certain portions of the west of Ireland; but in these parts it does not appear quite to reach 80 inches.

The West Highlands present the most extensive region of heaviest rainfall in the British Islands. The mountain-masses along whose slopes and plateaus the rainfall is precipitated, offer a practically unbroken face of Highlands directly in the course of the rain-bringing winds from the Atlantic. Particular attention is drawn to the circumstance that these mountain-masses present many lochs and valleys directly in the course of these winds, up which therefore the winds are borne, and these cooling as they ascend pour down the deluges of rain which deeply trench the sides of the mountains in the lines of their water-courses.

This region of heaviest rainfall lies so far to the north of Ireland that the rainfall is not lessened by a previous partial drying of the Atlantic winds in their passage thither. To southward, however, it is quite different. Over the whole of the extensive tract of Great Britain from Luss to the Lake District there is not a single rain-gauge whose annual average reaches 80 inches, even although a number of rain-gauges have been planted in the higher districts, and in positions likely to furnish approximately the maximum rainfall of these districts. The diminished rainfall is no doubt due to the partial drying of the Atlantic winds in their passage across Ireland before they reach Southern Scotland.

St. George's Channel and the Irish Sea open a free passage to the south-westerly winds, here diverted into a more southerly course, to the north of England and to Wales, and accordingly where the mountain masses of the Lake District and of North and South Wales oppose their course the rainfall over large portions of these high districts exceeds 80 inches.

The maximum falls in these four districts respectively are 185·96 inches at The Styx, in the Lake District; 128·50 inches at Glencroe, Argyllshire; 116·90 inches at Beddgelert, North Wales; and 96·18 inches at Ty-Draw-Treherbert, South Wales.

The largest region of 60 to 80 inches rainfall is in the West Highlands, surrounding the region of still larger rainfall of 80 inches and upwards, and it extends from the Crinan Canal to beyond Loch Assynt in Sutherland. Then follow the hills to the north of Galloway, the hills to the north and east of Dumfriesshire, large portions of the Lake District, of North and South Wales, of West Galway, the mountainous districts of Kerry, and Dartmoor in Devonshire.

[1] An Address delivered to the Philosophical Society of Glasgow on December 16, 1885, at the request of the Council, by Alexander Buchan.

An annual rainfall of 40 to 60 inches covers extensive tracts of the British Islands; a rainfall of at least 40 inches characterising the climates of about a fourth part of the surface of England, of about the half of Ireland, and considerably more than the half of Scotland, the latter taken as a whole being by far the rainiest of the three divisions of the United Kingdom. It is to be noted that nowhere along the east coast of Great Britain, or for some considerable distance inland, does the average rainfall anywhere reach 40 inches. In the east of Ireland, on the contrary, the rainfall exceeds 40 inches in Wicklow, the south of Down, and the middle districts of Antrim, which is probably due to the south-westerly winds being diverted into a more southerly direction in their passage through the Irish Sea.

Over the whole of the west of Great Britain the rainfall exceeds 40 inches annually, except from St. Bees' Head to Dumfries, and from Holyhead to Lancaster, these districts being largely protected from the rain-bringing winds by the Cumberland and the Welsh mountains respectively. It may also be stated that the rainfall of the Orkney and the Shetland Islands falls short of 40 inches, whereas in the Hebrides it exceeds that amount.

The shadings of blue on the map show in a striking manner the extension eastwards of the areas of the 40 inches and upwards annual rainfall by the mountains of Sutherland, the Grampians, the Cheviots, the Pennine Range, and the hilly ground of the south-western counties of England.

On the other hand, the breakdown at various intervals of the mountainous or hilly plateau which may be regarded as extending along the west of Great Britain from Cape Wrath to the Land's End has an equally striking influence on the distribution of the rainfall, and as regards man's material interests is even more important. Thus the opening of the Bristol Channel, between Wales and the Cornish Peninsula, is the avenue through which is spread a more generous rainfall over a large portion of Central England than would otherwise have been the case. Through the breakdown of the plateau between the Pennine Range and North Wales another large portion of England, extending from Cheshire round by Derbyshire, and thence northward through Yorkshire, has its rainfall also very materially increased.

But the most remarkable of these breakdowns is the great lowering of the water-parting between the Firths of Forth and Clyde. Through the opening thus formed the south-westerly winds pass freely, and overspread Dumbartonshire, Stirlingshire, and the whole of Western Perthshire, precipitating over these regions a rainfall truly western as regards its copiousness and the direction of the winds with which it falls; and through the same breakdown there is extended, even eastward through Kinross-shire, a rainfall of fully 40 inches—an amount which occurs nowhere else over comparatively level plains so far to the east of the water-parting between eastern and western districts.

Of the greatest importance is it to note the rainfall of Clydesdale, lying to the south of this breakdown. The amounts are, in inches, 29·98 at Bothwell Castle, 30·54 at Dalziel House, 31·66 at Auchinraith, and 32·37 at Murdostoun. Now it is simply the *southerly* element of the rain-bringing winds which makes the rainfall of the Hamilton district of Clydesdale so essentially different, both as respects its amount and the times of its occurrence, from that of the Clyde below Glasgow. It may be noticed here that when the rainfall of the west is in excess of the average the rainfall of West Perthshire is also in excess; and on the other hand, when there is an excessive rainfall over the Hamilton district, it generally occurs that the rainfall of eastern districts is also in excess. The peculiarity of the rainfall of Glasgow consists in this—that it lies midway between those districts which are so differently circumstanced.

The valleys of the counties of Kirkcudbright with Dumfries and the intervening ridges lie awthart the course of the rain-bringing winds, and show the inevitable result of a rainfall successively diminishing on advancing eastward. But on arriving in Eskdale, the most easterly of these valleys, we meet with a rainfall considerably in excess of that of any of the valleys to westward at the same elevations. The larger rainfall of Eskdale is due to its lying more in the line of the Solway, and having immediately to eastward a high mountainous region which the south-westerly winds must cross in their passage to eastward.

The distribution of the rainfall over this hilly region and over the valleys on each side of it is instructive. Thus at Kirkconnel Hall, near Ecclefechan, it is, in inches, 39·64; Canonbie, 49·72; Carlesgill, 58·00; Eskdalemuir, 63·30; Tudhope (on the ridge, 1961 feet high), 76·43; and on the east of the watershed at Teviothead, 54·86; Borthwickbrae, 44·36; Hawick, 33·55; and thence continues diminishing in descending the valley to 26·50 at Springwood Park, near Kelso. The reason why the rainfall of this region is thus distributed is that the air on the windward side of the ridge being suddenly raised to a greater height in crossing the range its temperature is continually reduced by mere expansion, and copious precipitation follows; whereas on the leeward side, as the air descends to lower levels, its pressure (or density) being increased, and its temperature also thereby increased, it gradually becomes drier, and accordingly the rainfall diminishes rapidly with the descent of the aërial current to the lower plains. A similar distribution of the rainfall is seen in crossing the Downs from Brighton to London, and over all other regions similarly situated.

It is the rapid increase of the temperature and drying of the air as the wind passes from high and wide plateaus into lower levels which determines the areas of least rainfall of the British Islands. Accordingly the smallest average annual rainfall, varying from about 22½ to 25 inches, occurs in England, and overspreads a large portion of the south-eastern counties extending from the Humber to the estuary of the Thames, exclusive of the higher grounds of Lincoln and Norfolk, where the rainfall rises above 25 inches. In every other part of the British Islands the rainfall is above 25 inches. The influence of the higher grounds of Norfolk and Lincoln in swelling the rainfall, most probably by increased falls with easterly winds, is very striking. Similarly the rainfall of the Yorkshire Wolds is in excess of surrounding districts. Between the valley of the Thames and the Humber the rainfall nowhere exceeds 30 inches, except near the Chiltern Hills.

It will be observed that the northern limit of the region marking off a rainfall under 25 inches annually is at the Humber, or near where Great Britain suddenly shrinks in breadth. It is, however, probable that the larger rainfall of the eastern part of Yorkshire, as compared with what obtains further south, may also, in part, be occasioned by causes analogous to those which give Western Perthshire its large rainfall.

In Scotland no rain-gauge gives an annual average under 25 inches. In three districts, however, the averages are only slightly in excess of 25 inches, and less than 27 inches: these districts being (1) Lower Tweeddale from about Coldstream to Jedburgh; (2) the low-lying parts of East Lothian; (3) the shores of the Moray Firth from the mouth of the Spey round to Tain. It will be seen that these districts are not only well protected by extensive highlands from the rains of the south-westerly winds, but also from the, in many cases, torrential downpours of south-easterly winds. It is this double protection which gives the driest of its climates to these parts of Scotland.

In Ireland, on the contrary, only a small district round Dublin shows a rainfall less than 30 inches, this district being well protected by the Wicklow mountains from the rain-bringing winds; and as in that island there is no continuous mountain-mass stretching north and south there is no such great difference of rainfall and temperature shown between the eastern and western climates of Ireland as in the case of Scotland and England.

The narrowness of the strip round the east of Scotland where the rainfall does not exceed 30 inches a year is an interesting feature, of which the rain-maps constructed for individual months suggest the explanation. Of the rainfall of eastern districts the larger proportion is due to easterly winds, and by much the larger portion of these falls usually takes place neither on the low-lying coasts, nor at any great distance inland, but in the intermediate region at heights from about 250 feet and upwards. The falls are also very heavy in low-lying valleys that open out so as to face these rain-bringing easterly winds. Of these rains the weather of October 1880 afforded an excellent illustration. The rains of that month fell with strong north-easterly winds, and the foreshores, looking to the north-east, of the Firth of Forth, the Moray Firth, and the Pentland Firth, had a monthly rainfall above the average, being in some places more than double the average; whereas over the rest of Scotland the rainfall was under the average, being over very extensive breadths from 70 to 98 per cent. less than the mean rainfall for October.

One of the most marked features of the climates of the south of England, to which many of our invalids are sent, is due to the influence of the Downs on the rainfall. Over the whole of the somewhat broad region occupied by the Downs the rainfall exceeds 30 inches, rising near Petersfield to 40 inches. Along the south coast, and for a varying distance inland as determined by the physical configuration, the average is less than 30 inches from Dover westward as far as the east shores of the Isle of Wight. On proceeding still farther westward, the annual rainfall slowly but steadily rises, till on rounding Prawle Point in Devonshire it begins to exceed 40 inches, and with this increase of the rainfall there is a still more striking increase of temperature in the winter months.

The whole of the results arrrived at in this inquiry show conclusively that the key to the distribution of the rainfall of the British Islands is the direction of the rain-bringing winds in their relation to the physical configuration of the surface.

Looked at broadly, there are four very distinct causes of rain, viz. (1) the moist south-westerly winds; (2) rains, often very heavy rains, from the east, extending but a little way inland; (3) the annual fall of temperature from August to January; and (4) those peculiar influences that have their fullest development in the thunderstorms of summer over low-lying extensive plains.

The rainfall of the British Islands has been examined with reference to its seasonal distribution in relation to the physical configuration of the surface. The mean amount of each place for the past twenty years has been calculated for the twelve months, these being reduced to thirty days each. The mean of these twelve months being taken, the mean monthly rainfall of the year was then ascertained, and with this latter mean each monthly mean was compared, and its excess, or defect, entered in percentages on twelve maps.

The moist south-westerly winds acquire their maximum annual predominance in December and January, and as these winds come loaded with the vapour of the Atlantic the rainfall rises above its monthly mean over nearly the whole of Scotland. Two patches, however, are to a great extent exempt, these being the districts lying on the lee side of the greatest stretch of mountainous land, viz. to the north-east of the Grampians and to the east of the Moffat and Lead Hills. Similarly, in England, during these months, the rainfall is considerably above the average over the whole of the dry districts extending from the Tweed southwards, and bounded on the west by the water-partings of the Mersey and the Severn, and on the south by the Thames, including the northern slopes of Kent.

During the great annual fall of temperature from August to January the greatest excess over the mean monthly rainfall occurs in September and October, when the fall of temperature is most rapid, south-westerly winds very prevalent, and heavy rains with easterly winds, chiefly the easterly winds of cyclones, of most frequent occurrence. In these months the rainfall reaches the annual maximum over large districts in the east of Scotland, and over all but the whole of England.

In northern and extreme western districts nearly all thunderstorms occur during the winter months, whereas few occur in eastern and central districts at this season; but nearly all occur in the summer months—a remark which applies with greatest force to the more extensive level, or comparatively level, portions of the country. Now, from the frequent occurrence of the thunderstorms and thunder-showers, the annual rainfall of these districts approaches to, and in not a few cases reaches, the annual maximum in the summer months. The local excess begins to show in June, and is extended in July much more decidedly over the agricultural districts of England and Scotland that are best suited for the ripening of wheat and barley. In August there is shown a still further development and extension of the summer rains over these and adjoining districts. It is to be noted, however, that during this time the rainfall remains under the average over the extreme south-western, southern, and south-eastern districts of England. In these characteristics of the summer rainfall these important agricultural centres resemble the climates of Central Europe, where the rainfall rises to the maximum during the summer months

The following are the annual amounts of the rainfall, in inches, in certain districts and along certain lines radiating from Glasgow:—Glasgow 40·20, Bresley Hill 37·33, Bothwell Castle 29·98, Dalziel House 30·50, Lanark 35·66, Wiston 45·33; Queen Park 36·24, Newton Mearns 52·63, Black Loch 57·60; Paisley 45.37, Castle Semple 52·10, Blair 53·62, Ardrossan 41·03; Kilbarchan 57·28, Kilmalcolm 57·28, Greenock 64·25, Overton 71·45; New Kilpatrick 48·05, Dumbarton 48·25, Cameron House 62·95, Luss 80·45, Firkin 96·05, and Ardlui 115·46. These figures show in a striking manner the extraordinary variations of climates there are in the immediate neighbourhood, or within easy reach, of Glasgow. Quite recently an inquiry was set on foot in Berlin, where numerous rain-gauges were planted with the view of arriving at some clear understanding as to the amount of observational information required in order to state definitely what the actual rainfall of a district is. Might I suggest to the Mathematical and Physical Section of the Philosophical Society that a similar investigation be taken in hand, and forty or more rain-gauges be added to those already in use. In a few years not only would they be able to answer the question proposed by the Berlin meteorologists, but in answering it they would state with satisfactory precision the character and limits of the various local climates which differ so widely from each other in the neighbourhood of Glasgow.

THE AUSTRALIAN MUSEUM, SYDNEY[1]

(1) THE Museum has been, during the year 1884, as in previous years, open to the public daily, except on Mondays, when it is necessarily closed for the purpose of cleaning. The largest attendance on any one day was on December 26, when 1643 persons were registered at the doorway. The greatest Sunday attendance was 1315, on April 13. The average daily number of visitors throughout the year was 262 on week-days and 853 on Sundays. The total for the year is 126,040.

(2) The collections are still being increased by means of purchases, exchanges, collecting expeditions, and donations. A list of these additions, under their separate heads, will be found in Appendices V., VI., VII., VIII. Among these may be specially mentioned several pairs of large antelopes from South Africa, a full-grown ourang-outang of the larger species (*Simia satyrus*), and several of the smaller species (*S. morio*): a fine specimen of the Chimpanzee (*Troglodytes niger*); two whales, one from Kiama (*Physeter macrocephalus*), and one from the coast of England, belonging to the extremely rare species known as Rudolf's Whale (*Balænoptera borealis*); casts of gigantic fossil remains from the British Museum, including *Elephas ganesa*, *Mastodon andium*, *Toxodon platensis*, *Sivatherium giganteum*, *Megalania prisca*, &c.; and large and important ethnological collections.

(3) Great alterations and improvements have been effected by the erection of additional wall-cases, constructed upon the best principles and at considerable cost, for the reception of large collections of skeletons and Australian fossil remains; and for groups of Birds of Paradise, and other exhibits of great interest from New Guinea and elsewhere. Additional cases and cabinets have been provided for the mineral collections, and others are in course of construction for similar purposes.

(4) Want of sufficient space in the present building is still felt as a serious drawback to the usefulness of the Museum. The Trustees nevertheless gladly express their obligation to the Government for the provision now made for further accommodation. An additional shed has been erected, which is used as a store for timber and other material. A large iron workshop has also been provided, and another of similar dimensions is in course of erection. These are to be used for the storage of spirits and bottles, and for workrooms in connection with spirit specimens.

(5) Catalogues, not only of the various collections in the Museum, but also of all branches of Australian Zoology, are still in course of preparation; but no new publications have been issued during the past year.

(6) Mr. Ramsay's visit to Europe in connection with the International Fisheries Exhibition enabled him to examine various Museums, Zoological Stations, and Aquaria, and has been productive of much advantage to this Museum. A report, with particulars of his proceedings and details of his arrangements for purchase and exchange of specimens, will be found in Appendix XI.

(7) The exhibits which are sent to the Calcutta Exhibition have been presented by the Trustees to the Government of India.

(8) The Teaching Collection, consisting of skeletons, models, and specimens illustrative of comparative anatomy and natural history, which for some years past occupied the north room in the upper floor of the Museum, has been transferred to the University. This collection was specially prepared for teaching purposes, and, as most of the specimens were already represented in the Museum, and it occupied space which could be better used for the display of other objects of interest, the

[1] Report of the Trustees for 1884.

Trustees felt themselves justified in making the transfer. Although this collection is now at the University, its ownership remains with the Trustees.

9. There has been no change in the Board during the year, by death or otherwise.

10. Annexed to this Report are the following Appendices :—

I.—Annual Balance-sheet.
II.—Attendance of Visitors.
III.—Attendance of the Trustees.
IV.—Work done by Taxidermist and Articulator.
V.—Specimens collected.
VI.—Specimens purchased.
VII.—Exchanges.
VIII.—Donations.
IX.—Books acquired.
X.—Duplicate Books.
XI.—Mr. Ramsay's Report.

(Signed) ALFRED STEPHEN,
Crown Trustee and Chairman

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Special Board for Medicine have presented to the Vice-Chancellor the following Report with a view to its communication to the Senate :—"The Board have considered the requirements of the Previous Examination from the point of view of its suitability as a preliminary examination for students entering on the study of medicine, and have come to the conclusion that in the interests of mental training these requirements may with advantage be modified. They would desire to see introduced an adequate examination in the elementary mechanical principles of Physics, meaning thereby—the fundamental notions of matter, motion, and energy, and the simple laws which govern their relations ; the physical properties of matter in the solid, liquid, and gaseous states ; and the application of these properties and laws in the case of simple instruments and machines. An examination in these principles need not involve any but the most elementary mathematics, yet it could be made to exercise the student in clearness of conception, in accuracy of statement, and in soundness of reasoning. These qualities are in a special degree essential to students of medicine, but from our Report of November 11, 1885, it would appear that in these respects the preliminary training of many who propose to become students of medicine has not been satisfactory. The subject we propose is already well taught and appreciated in many good schools, and it appears to us extremely desirable that the University should encourage all schools to improve themselves in this direction by including the subject in its Previous Examination. It is not for the Board to say whether the subject should form part of the Previous Examination proper (though many considerations might be urged for this plan), or be required as an additional subject in place of the present examination in Elementary Mechanics. They are, however, persuaded that, if introduced in some form, the examination would be for all students at least of equal value to the present examination in additional subjects, and for students whose work at the University is to consist largely in the study of nature it would be of considerably greater value."

Mr. H. D. Rolleston, of St. John's College, has been appointed Assistant Demonstrator of Physiology, in succession to Mr. Green. Mr. Rolleston was placed in the First Class in the Natural Sciences Tripos, Part I., in the Easter Term, 1885.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 12, December 1885.—J. Fink, on the influence of pressure on the electric resistance of electrolytes. Cailletet's apparatus was used for producing compression, Kohlrausch's induction apparatus for the electric measurements. A solution of hydrochloric acid (5·02 per cent.), having a resistance of 7·490 Siemens' units at 1 atmo., fell to 7·335 at 200, and to 7·126 at 500 atmos. A weaker solution (0·98 per cent.) showed a diminution of 7·39 per cent. in its resistance at 500 atmos. A similar solution of zincic sulphate showed a diminution of 11·74 per cent. The diminution is proportional up to 300 atmos.—E. Edlund, on the transition-resistance in the voltaic arc. The conclusion is against the existence of such a resistance.—K. Wesendonck, on the fluorescence of naphthalin-red.—H. W. Vogel, on the relation between absorption by colouring matters and their sensitising action on bromide of silver.—G. Kötschau, studies on fluid motions. Some very extraordinary figures are produced by careful introduction of a coloured liquid into an uncoloured one.—F. Himstedt, a determination of the ohm. This paper describes the method, depending on a knowledge of the coefficient of mutual induction of two coils, which has already been discussed by Lord Rayleigh, and which is similar to that of Roiti. The final result gives as equivalent to the ohm a column of mercury of 1 square millimetre section and 105·98 centimetres length.—W. B. Brace, on the magnetic rotation of the plane of polarisation, and some special cases of refraction. It is shown that there may be in a calc-spar crystal three rays which suffer no double refraction. Experiments are also described concerning prisms of heavy glass in a magnetic field.—G. Stern, position of the commutator in electro-dynamic machines. A discussion of Clausius' formulæ with respect to the relation of the current to the angle of lead.—E. Mach and J. Wenzel, a contribution to the mechanics of explosions.—K. L. Bauer, apparatus for demonstrating that electricity resides only on the surface of a conductor. This is a modification of Biot's apparatus, consisting of two concentric hemispheres, and convenient means of insulating and discharging.

Journal of the Russian Chemical and Physical Society, vol. xvii. fasc. 7.—On the part played by contact actions in the phenomena of dissociation, by D. Konovaloff.—Thermic data for some combinations of the aromatic series, by E. Werner, being numerical data as to the heat of neutralisation of saligenin and oxybenzoic aldehydes and acids, and mellic acid.—On the oxidation of oleic and elaidic acids by permanganate of potassium, by A. Saytzeff.—Notes by MM. Albitzky, Nikolsky, and Ustinoff.—On the motion of a solid body having cavities filled with a homogeneous liquid, by M. Joukowsky, being the second part of a mathematical inquiry into ellipsoidal, cylindrical, and such other cavities as have the shape of a rotation-body, and also several cavities connected together.—On the collision of absolutely solid bodies, by M. Schiller, second part, being a further mathematical development of the theory, together with answers to Prof. Joukowsky's observations.—On the influence of an electric current on the resistance of selenium and its sensibility to light, by N. Heschus, being an explanation of the experiments of Fritts by the theory of allotropic dissociation.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 17, 1885.—"On the Formation of Vortex-Rings by Drops falling into Liquids." By Prof. J. J. Thomson, M.A., F.R.S., and H. F. Newall, M.A.

When a drop of ink falls into water from not too great a height, it descends through the water as a ring, in which there is considerable rotation about the circular axis passing through the centres of its cross-sections ; as the ring travels downwards, inequalities appear, and the ring breaks up into a number of smaller rings, which in turn may again subdivide.

It is shown that capillarity plays no essential part in the formation of the rings ; in fact, it may be said that, with very few exceptions, rings are formed only when a liquid is dropped into one with which it can thoroughly mix. There are very many cases in which rings are formed when there is no possibility of capillary action, such as when the liquid into which the drop falls is the same as the drop itself.

The drops were observed by instantaneous illumination ; and it was seen that the drop enters the liquid as a sphere, becomes flattened as it descends, and finally breaks into a ring more than half an inch below the surface.

When a sphere moves through a liquid, the tangential velocity of the liquid is different from that of the sphere. If the sphere be a liquid drop, there is no absolute discontinuity in the motion, but only a very rapid change, so that there is a finite alteration in a very small distance. This is equivalent to a vortex-film covering the sphere, the lines of vortex-motion being horizontal circles. If the liquid be viscous, the vorticity will diffuse inwards and outwards. The drop, as it falls, becomes flattened, on account of the resistance to its fall ; and if by the time it becomes disk-shaped the drop is full of vortex-motion, the disk must break up—for it is an unstable arrangement of vortex-motion—and assume the stable arrangement, namely, that of the anchor-ring. Then the most important property of the liquid involved is its viscosity. If this is too small, the vortex-motion will not have time to spread far by the time the drop has become disk-shaped; whilst if the viscosity is too great, the vortex-motion will all be dissipated before the drop becomes disk-shaped.

To avoid complication, experiments were made in which drops were let fall into liquid of the same kind as that composing the drop. Liquids so treated were found to arrange themselves into four classes, distinguishable by the character of the ring formed. The quotient μ/ρ was determined for each of the liquids—μ being the coefficient of viscosity found by Poiseuille's capillary tube method, and ρ the density, water being the standard in both cases. It was then found that the four classes were also distinguishable by the value for μ/ρ.

Thus in Class I. ether, chloroform, and carbon bisulphide give rings only very uncertainly, the drop breaking up and spreading irregularly through the column of liquid. For these μ/ρ is not greater than 0·7.

To Class II. belong water, alcohol, turpentine, paraffin, and other liquids; these give the best rings: and for them the value of μ/ρ is between 1 and 3.

For Class III. μ/ρ is between 3 and probably 8 or 10: and this class includes moderately viscous liquids, such as butyl-alcohol, amyl-alcohol, fairly strong sulphuric acid, and diluted glycerine. In these cases the rings form very slowly.

Class IV. includes all the most viscous liquids, like strong solutions of sugar, potash, sulphuric acid, glycerine. The value of μ/ρ is much larger (about 15 to 30), and no ring is formed at all, unless special precautions are taken to get very large drops.

It is pointed out that nothing can depend on the absolute value of μ/ρ, since it has the dimensions of the product of a length and a velocity. The naturally comparable length in the system is the size of the drop. It is shown that diminishing the size of the drop has the same effect as increasing the value of μ/ρ. The velocity of the drop is probably the comparable velocity; but this cannot be varied much without introducing large disturbances.

The more complicated problem of a drop of one liquid falling into a vessel of a different liquid is treated briefly, and the analogy of the diffusion of vortex-motion with the conduction of heat is referred to; μ/ρ, in the present problem, corresponding with the diffusivity in the conduction of heat.

The breaking up and subdivision of the rings is shown to depend on (1) motion in the column, which brings about irregularities in the ring, when the vortex-motion has nearly or quite died out; (2) the difference of density of the liquids composing the drop and the column, on account of which the parts of the ring, in which most of the liquid is gathered, fall most quickly, and give rise to rings in the same way as that in which the original ring was formed. Strong evidence is adduced to show that capillarity is not concerned in the subdivision.

Instances in which a small surface tension exists are also referred to, and figures of some curious cases are given.

The paper closes with a section in which it is shown that a connection exists between the depth to which a ring travels in the column and the form of the drop at the moment of impact at the surface of the column.

January 14.—Abstract of a Paper "On the Action of Sunlight on Micro-organisms, &c." By Arthur Downes, M.D.

In previous memoirs (*Proc. Roy. Soc.*, 1877-8-9), of which preliminary notes appeared in NATURE, Dr. Downes, with the collaboration of Mr. T. Blunt, showed that sunlight was fatal to Microsaprophytes by a process of hyper-oxidation thereby induced.

In this process the more refrangible rays were the most active. In the course of the induction which led to this conclusion two other facts of importance were elicited. The molecule of oxalic acid was speedily resolved into water and carbonic acid by the combined effect of light and free oxygen, and a typical representative of the diastases, the invertive ferment of cane-sugar, had its qualities completely destroyed by sunlight, which was, however, without effect in a vacuum or a neutral atmosphere.

During the past eight years evidence confirmatory of these conclusions has accumulated from various sources, and the principal facts are reviewed by the author.

After referring to the observations of Warington and others on the nitrifying ferment, of Tyndall in regard to the insolation of putrefiable infusions under an Alpine sun, and to others, Dr. Downes summarises the recent results of Duclaux, who finds, from an examination of several species, that *Micrococci* are apparently far more sensitive to sunlight than the more resistant *spore-forming Bacilli*. Duclaux, who has likewise observed the destructive effect of sunlight on a diastase, agrees that this injurious action on germs is an affair of oxidation. In his previous papers the author had noted the different powers of resistance of various organisms to sunlight, notably of *Saccharomycetes* or *Mucedines*, as compared with *Bacteria*. He now describes a specially resistant *Bacterium*, roughly resembling, but not identical with, the *Ascobacterium* of van Tieghem, of which he finds no previous record.

In refuting the conclusion of Jamieson, an Australian observer, that both he and Prof. Tyndall had mistaken effects of heat for effects of radiant energy distinct from heat, Dr. Downes describes recent experiments of his own, which indicate that a similar action, though of course in a less degree, is exercised by diffused light. He concludes with a reference to the well-known observations of Pringsheim on the destruction of vegetable protoplasm by the more refrangible rays, and claims them as evidence of the truth of his former generalisation that the hyperoxidation of protoplasm by light is a general law from the action of which living organisms require to be shielded by a variety of protective developments of cell-wall, aggregation of tissue or colouring matter, and in other ways.

January 21.—"On the Clark Cell as a Standard of Electromotive Force." By Lord Rayleigh, M.A., D.C.L., Sec.R.S.

This paper, supplementary to that "On the Electrochemical Equivalent of Silver, and on the Absolute Electromotive Force of Clark Cells" (*Phil. Trans.*, part 2, 1884), gives the further history of the cells there spoken of, and discusses the relative advantages of various modes of preparation. The greatest errors arise from the liquid failing to be saturated with zinc sulphate, in which case the electromotive force is too high. The opposite error of *super*-saturation is met with in certain cases, especially when the cells have been heated during or after charging. Experiments are detailed describing how cells originally supersaturated have been corrected, and how in others the electromotive force has been reduced by the occurrence of supersaturation consequent on heating. If these errors be avoided, as may easily be done; if the mercury be pure (preferably distilled *in vacuo*); and if either the paste be originally neutralised (with zinc carbonate), or a few weeks be allowed to elapse (during which the solution is supposed to neutralise itself), the electromotive force appears to be trustworthy to 1/1000 part. This conclusion is founded upon the comparison of a large number of cells prepared by the author and by other physicists, including Dr. Alder Wright, Mr. M. Evans, Dr. Fleming, Prof. Forbes, and Mr. Threlfall.

As regards temperature coefficient, no important variation has been discovered in saturated cells, whether prepared by the author or by others. In all cases we may take with abundant accuracy for ordinary applications—

$$E = 1{\cdot}435\{1 - 0{\cdot}00077\,(t - 15^\circ)\},$$

the temperature being reckoned in Centigrade degrees. For purposes of great delicacy it is advisable to protect the standards from large fluctuations of temperature. Under favourable circumstances two cells will retain their relative values to 1/10,000 for weeks or months together.

Unless carefully sealed up, the cells lose liquid by exudation and evaporation, and then the electromotive force gradually falls. Marine glue appears to afford a better protection than paraffin-wax, and there seems to be no reason why cells thus secured should not remain in good order for several years.

In cells of the H-construction (§ 29 of former paper), the leg containing the amalgam (but not the one containing pure mercury) is liable to burst, apparently in consequence of a tendency to alloy with the platinum. Protection with cement of the part of the platinum next the glass has been tried, but no decisive judgment as to the adequacy of this plan can as yet be given.

Recent cells, intended for solid zincs, have been made of a simplified pattern—nothing more, in fact, than a small tube with a platinum wire sealed through its closed end. The zincs are not re-cast, and the paste is prepared from (unwashed) mercurous sulphate rubbed up in a mortar with *saturated* solution of zinc sulphate and a little zinc carbonate. A stock of paste may be prepared and retained for use in a bottle.

Experiments are described tending to prove that the irregularities observed during the first few weeks of the life of a cell prepared with acid materials have their origin principally at the mercury electrode.

Cells prepared with dilute solutions have a lower temperature coefficient (about 0·00038), but would be more difficult to use as standards whose value is to be inferred from the mode of preparation.

Details are given of H-cells charged with amalgams of zinc and mercury in both legs, without mercurous sulphate. A very small proportion of zinc is sufficient to produce the maximum effect. Pure mercury, neither alloyed with zinc nor in contact with mercurous sulphate, has an uncertain electromotive value.

Since the comparison of cells does not absolutely exclude a small general alteration of electromotive force with age, further determinations of the standard cell (No. 1) have been effected by means of the silver voltameter. The results—

TABLE XVIII.

Date	E.M.F. of No. 1 at 15° C. in B.A. volts.
October 1883 to April 1884	1·4542
November 1884	1·4540
August 1885	1·4537

are very satisfactory, and indicate a constancy sufficient for almost all practical purposes.

Finally, some comparisons are given between Clark cells and Daniells, with equi-dense solutions, both of Raoult's pattern and of that described recently by Dr. Fleming.

Entomological Society, January 20.—Fifty-third Anniversary Meeting.—Mr. R. McLachlan, F.R.S., President, in the chair.—An abstract of the Treasurer's accounts was read by Mr. H. T. Stainton, F.R.S., one of the auditors, and the Secretary read the report of the Council.—The following gentlemen were then elected as the Council for 1886:—President: Robert McLachlan, F.R.S.; Treasurer: Edward Saunders, F.L.S.; Secretaries: Herbert Goss, F.L.S., and the Rev. W. W. Fowler, M.A., F.L.S.; Librarian: Ferdinand Grut, F.L.S.; other Members of Council: T. R. Billups, Edward A. Fitch, F.L.S., F. Du Cane Godman, M.A., F.R.S., W. F. Kirby, E. B. Poulton, M.A., F.G.S., H. T. Stainton, F.R.S., S. Stevens, F.L.S., and J. Jenner Weir, F.L.S.—The President then delivered an address, and a vote of thanks to him was moved by Mr. Stainton, and seconded by Mr. F. Pascoe, and the President then replied. A vote of thanks to the officers was then moved by Mr. J. W. Dunning, and seconded by Mr. Distant, and Messrs. Saunders, Fitch, Kirby, and Grut replied. This was the first annual meeting since the incorporation of the Society by Royal Charter.

Zoological Society, February 2.—Prof. W. H. Flower, V.P.R.S., President, in the chair.—Mr. W. B. Tegetmeier, F.Z.S., exhibited and made remarks on a Pheasant from the Persian borders of Transcaucasia.—Mr. C. A. Wright, F.Z.S., exhibited a Dove of the genus *Turtur* from Malta, and identified it as a semi-albino variety of *Turtur auritus*.—Mr. Sclater exhibited, on behalf of Mr. W. H. Dobie, a young specimen of Sabine's Gull (*Xema sabinii*), which had been obtained at Mostyn, on the coast of Flintshire.—Mr. Seebohm exhibited a specimen of Ross's Sea-Gull (*Larus rossi*) obtained in June last in the neighbourhood of Christianhaab, Disco Bay, Greenland.—Capt. R. G. Wardlaw Ramsay exhibited and remarked on a specimen of a new bird of the genus *Copsychus* obtained by Mr. H. Pryer in North-Eastern Borneo, which he proposed to call *C. niger*.—A communication was read from Prof. R. Collett, C.M.Z.S., containing an account of the external characters of the Northern Fin-Whale (*Balænoptera borealis*), based upon the examination of numerous specimens of this whale killed on the coast of Norway during the past summer.—A communication was read from Dr. G. Stewardson Brady, F.R.S., containing descriptions of some new freshwater Entomostracous Crustaceans from South Australia.—Dr. H. Woodward, F.Z.S., communicated, on behalf of Dr. Monticelli, a catalogue of the species of Bats found in South Italy.—Mr. R. B. Sharpe, F.Z.S., read the first of a series of notes on birds in the Hume Collection. The present communication treated of the specimens supposed to belong to the Hawfinch of Europe, which had been collected at Attock, and showed that they belong to a different species, which Mr. Sharpe proposed to call *Coccothraustes humii*.—Mr. F. E. Beddard read the third of his series of notes on the Isopoda collected during the voyage of H.M.S. *Challenger*. The present paper completed the preliminary description of the new species of this group collected during the voyage, which amounted altogether to about forty-five in number.—Mr. J. H. Leech, F.Z.S., exhibited and described specimens of a Butterfly from Mogador, which he referred to a variety of *Anthocharis eupheno*.

Geological Society, January 27.—Prof. T. G. Bonney, F.R.S., President, in the chair.—H. Kirby Atkinson was elected a Fellow, and Prof. Gustav Tschermak, of Vienna, a Foreign Member of the Society.—The following communications were read:—On the fossil Mammalia of Maragha, in North-Western Persia, by R. Lydekker, F.G.S.—On the Pliocene of Maragha, Persia, and its resemblance to that of Pikermi, in Greece; on fossil elephant-remains of Caucasia and Persia; and on the results of a monograph of the fossil elephants of Germany and Italy, by Dr. H. Pohlig. Communicated by Dr. G. J. Hinde, F.G.S.—The Thames Valley surface-deposits of the Ealing district and their associated Palæothic floors, by John Allen Brown. Communicated by A. Ramsay, F.G.S.

Victoria (Philosophical) Institute, January 18.—Rev. Dr. Thornton in the chair.—A paper upon "A Samoan Tradition of Creation and the Deluge" was read by the Rev. T. Powell, F.L.S. Mr. Powell said he thought the Samoans were of Semitic origin; and if Hebrew characters had been used instead of the Roman alphabet for the writing of their language, the triliteral, Semitic nature of the language, in which hundreds of words were identical with Hebrew, would have been obvious.

MANCHESTER

Literary and Philosophical Society, November 3, 1885.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—On the different arrangements in a state of maximum density of equal spherical granules, by R. F. Gwyther, M.A.—Note on the velocity with which air rushes into a vacuum, and on some phenomena attending the discharge of atmospheres of higher, into atmospheres of lower, density, by Mr. Henry Wilde. Since the reading of my paper before the Society on the efflux of air, I have thought that it might be useful to recapitulate, briefly, the fundamental grounds upon which my experiments and the general reasoning thereon were based. This appears to me to be further necessary, from the dual sense in which the term "velocity" may be considered in the discharge of elastic fluids: the term, as I have already pointed out, has been applied by some, indifferently, to express the rate of increase of volume after leaving the aperture, and the velocity of the stream through the aperture before expansion. It is in the latter sense that the term is used in my paper, and the velocities shown in the several tables have been calculated on this basis. The application of the laws of discharge of inelastic fluids to those which are elastic is a natural principle of reasoning sufficient for us to assume a theoretic velocity for air rushing into a vacuum of 1332 feet per second; and the corollary to this proposition, that the velocity of efflux through the aperture into a vacuum is the same for all pressures above and below that of the atmosphere also follows, naturally and directly, from the reciprocal relations of the elasticity and density of the homogeneous atmosphere. But, just as the theoretic velocity of discharge of water and other inelastic fluids is diminished by the opposing motions and friction of the issuing stream of particles, so that the amount of discharge is only ·62 of that required by theory; so from the varied mobility of different gases there was an antecedent probability that an ideal law would not prevail for the velocity with which air has been assumed to flow into a vacuum. Hence, just as the hydraulic coefficient ·62, expressing the actual amount of efflux through a hole in a thin plate, could only be arrived at by experiment; so by experiment only could the actual velocity with which the atmosphere rushes into a vacuum be ascertained. This velocity, therefore, as determined by experiment, may be represented by the coefficient ·77 for the contracted vein. Or, $V = {\cdot}77 \times 1332 = 1025$ feet per second. From Tables I. and II. it appears that the corollary of the equality of the velocities for all pressures, when air flows into a vacuum, is not strictly applicable for the lower pressures, but is approximately true for pressures above 120 lbs. That air of lower density acts as a vacuum to the discharge into it of air of higher density, under certain conditions, is a truth so well established from the experiments described as to require no further proof, but, that the reduction of temperature at the orifice of the discharging vessel did not sensibly affect the velocity of the air through the orifice under such conditions, was evident from an inspection of the tables, and more particularly of Table V., where a pressure of six atmospheres acts as a vacuum to a pressure of nine atmospheres. In this experiment it will also be seen that 21·22 cubic inches of air, of a constant density of nine atmospheres (the equivalent of 5 lbs. of pressure), were discharged successively into a vacuum and into atmospheres of increasing densities up to six atmospheres, when the several discharges were made in equal times, viz. 7·5 seconds. Now, the velocity for this time, as shown in Table I., is 1210 feet per second for the contracted vein, and as the times were equal, so were the velocities equal, for the successive discharges up to six atmospheres. The velocity for low pressures, as I have shown in Table III., is compounded of the rate of discharge into a vacuum and the resistance of the atmosphere, and approximates to the square roots of the pressures. For effective pressures below 1 lb. above the atmosphere the rates of discharge are as the square roots of the pressures, as has been shown by Dr. Joule in the paper previously referred to. That the phenomenal rates of discharge which I have described are manifested whenever slight differences of pressure exist between the discharging and receiving atmospheres, may be inferred from the familiar experiment of fixing a perforated disk of cardboard by its centre to the end of a small metal tube or a piece of tobacco-pipe; when a similar plain disk, placed on, or against the other, instead of being driven off by a jet of air blown through the pipe, is attracted to it.

SYDNEY

Linnean Society of New South Wales, October 28, 1885.—Mr. C. S. Wilkinson, F.L.S., Vice-President, in the chair.—The following papers were read:—Notes from the Australian Museum, by R. von Lendenfeld, Ph.D. Note 1.—The vestibule space of *Dendrilla cavernosa*. In this note a very remarkable structure is described; the sponge forms wide ramified tubes with thin walls; and the terminations of these tubes are closed by sieves, as in *Euplectella*. Rings of sensitive and ganglia cells are described round the pores in this membrane. Gland cells similar to those of other *Aplysillidæ* are also described. Note 2.—*Raphyrus hixonii*, a new gigantic sponge from Port Jackson. A sponge, weighing over 400 lbs., was recently dredged in Port Jackson. A detailed description of it is given in this note. The author wishes to keep the two genera *Papillina* and *Raphyrus*, combined by O. Schmidt and Norman, distinct. He has found, besides the spicules known of the European species, two other kinds in this Australian sponge. The structure of the whole sponge is reticulate, as in the Auleninæ. Remarkable, very granular, amœboid cells, which are very abundant around the inhalant lacunes, are described as digestive cells. Note 3.—*Halme tingens*, n.sp. A sponge with peculiar staining qualities. This is a sponge from Thursday Island, which becomes blue after some time, and stains paper, &c., placed in the same spirit with it a remarkably dark blue. The spirit remains light yellow. The author thinks that this colour might be turned to practical account. Note 4.—A case of mimicry. Four sponges are described and photographed in this note. Two are *Ceraospongiæ*, and two are *Monactinellæ*. The two former belong to the genus *Chalinopsis*, R. von L.; the two latter to the genus *Dactylochalina*. The author agrees with Vosmaer that the horny sponges have descended from the *Monactinellid* siliceous sponges. Forms like those described connect the two groups. Their similarity in external appearance is considered a case of mimicry. Whilst the internal structure changed, and the sponge lost its spicules, it kept up a close resemblance to the ancestral siliceous sponge which was defended by its spicules. The case is a very interesting one.—Descriptions of some new or rare Australian fishes, by E. P. Ramsay, F.R.S.E., and J. Douglas-Ogilby. The species here described are *Pteroplatea australis*, *Sebastes scaber*, and *Platycephalus arenarius*, all new species, and *Cirrhitichthys graphidopterum* and *Lepidotrigla pleuracanthica*, species previously known.—On the genus *Trachichthys*, by J. Douglas-Ogilby. A full description and synonymy of the genus is here given, the author expressing an opinion that the *T. australis*, Shaw, and *T. jacksonensis*, Macleay, are the same species.—Catalogue of Australian Coleoptera, part ii., by George Masters. The families catalogued in this part are the *Dytiscidæ*, *Gyrinidæ*, *Staphylinidæ*, *Pselaphidæ*, *Paussidæ*, *Scydmænidæ*, *Silphidæ*, *Trichopterygidæ*, *Scaphididæ*, *Histeridæ*, *Phalacridæ*, *Nitidulidæ*, *Trogositidæ*, *Colydidæ*, *Rhysodidæ*, *Cucujidæ*, *Cryptophagidæ*, *Latrididæ*, *Mycetophagidæ*, *Dermestidæ*, *Byrrhidæ*, *Georyssidæ*, *Parnidæ*, *Heteroceridæ*—in all, 970 species.—The Plagiostomata of the Pacific, part iii., by N. de Miklouho-Maclay and William Macleay, F.L.S. Three fishes are here described: (1) A *Heterodontus* from the Chinese Seas, identified as the true *Heterodontus zebra* of Gray, hitherto looked upon as a synonym of *H. phillippi*; (2) a species of ray (*Myliobatis punctatus*), taken in 1879 in the Lub or Hermit Islands, north of the Admiralty Group; and (3) a ray from Sorry Island, north-west of the Admiralties, which is placed in a new genus of the *Trygonidæ*, and named *Discobatis marginipinnis*.—Fourth addendum to the Monograph of the Australian Hydromedusæ, by R. von Lendenfeld, Ph.D. In this paper a new species of Hydra is described, which possesses six arms, and on them cells, which the author considers more nearly allied to the Palpocils of Sarsia (Schulze) than the ganglia cells of Hydra.—Prof. Selenka's researches into the development of the American opossum, by R. von Lendenfeld, Ph.D. Prof. E. Selenka's most important discoveries regarding the concupiscence and the commencement of the development of the embryo of this marsupial are enumerated in this short preliminary report.—Second note on Macrodontism, by N. de Miklouho-Maclay. The author states his opinion about the very large teeth which he has observed in natives of different islands of Melanesia. The results of observations during his last two trips (1879 and 1882) to the Admiralty and Lub Islands is the conclusion that the enlargement of the teeth is nothing but an *excessive accumulation of a special kind of tartar* deposited on the incisors and canines of the upper and lower jaw.—Note on the "Kéu" of the Maclay Coast, New Guinea, by N. de Miklouho-Maclay. On the authority of the late Dr. R. Scheffer, Director of the Botanical Garden of Buitenzorg, Java, the author states that *two* species of *Piper*, allied to *Piper methysticum*, but different from it, were brought by him in 1873 from the Maclay Coast. The author gives a full description of the preparation of the "Kéu"-drink on the Maclay Coast, as well as of the effects of the same, which are more soporific than intoxicating. He adds further some remarks about the general use of the "Kava" root (*Piper methysticum*) throughout the islands of the Pacific.

PARIS

Academy of Sciences, February 1.—M. Jurien de la Gravière, President, in the chair.—On the theory of Mitchell's screw-pile, and on the "vrille," a small apparatus terminating in a sort of conic screw, used for making the scarfs of borings with the screw-pile, by M. H. Resal.—On the measurement of the velocity with which vibrations are propagated in the ground, by MM. F. Fouqué and Michel Lévy. They describe an instrument which they have invented for the purpose of automatically recording the velocity of propagation, as well as the intensity and duration of vibrations such as those produced by the blow of a Nasmyth hammer.—Note on some hyperelliptical formulas, by M. Brioschi.—Report on M. Romieu's work entitled "Essai sur les décans égyptiens," by M. Jules Oppert. In this work the author has endeavoured with partial success to determine the names of the thirty-six so-called "decans," stars which played such a large part in ancient Egyptian astronomy.—Determination of the constant of astronomic refraction by meridian observations (continued), by M. A. Gaillot.—On the integrals of total differentials of the second species, by M. E. Picard.—Geometrical theory of the articulated hyperboloid, by M. A. Mannheim.—Experimental verification of a new geometrical representation of the colour-sensations, by M. R. Feret. After establishing certain properties of the colour-sensations, and founding on them the principles of a new diagram representing these sensations, the author proceeds to show that the results furnished by experience harmonise at all points with those anticipated theoretically. But although the theory leads to the same equations as those already determined by Maxwell, it differs essentially from them in so far as it is founded on the rule of the parallelogram, and is independent of the notion of the three fundamental colours.—Thermic researches on hypophosphoric acid, by M. A. Joly. The thermic properties of the two hydrates of phosphoric acid already determined are compared with those of the various hydrates of phosphoric and arsenic acid, the study of which the author has now completed. Hypophosphoric acid is further compared with the other acids of phosphorus and arsenic by studying its saturation with an alkaline base, and two metallic bases, the oxide of manganese and the oxide of silver.—Note on the indicators of the different energies of the polybasic acids, by M. R. Engel.—A study of chlorophyll, in connection with M. Regnard's induction that the chlorophyll function, that is, the property of decomposing carbonic acid in the light, is of a purely chemical order, inherent to chlorophyll, and continuing to act apart from the physiological conditions, by M. Victor Jodin. Without denying this conclusion the author recalls certain former experiments, which apparently point at a different result, and which should be taken into consideration in order to establish a general theory of chlorophyll based on all the known facts.—On the morphology of the ovary in insects, by M. Armand Sabatier.—A contribution to the anatomy of the Chlorœmidæ, by M. Et. Jourdan.—Observations in connection with M. Köhler's recent note on a new species of Balanoglossus, by M. G. Pouchet. It is shown that this species is identical with that which MM. de Guerne and Barrois found in abundance in 1880 in the Island of Loch (Glenans Archipelago), and is also probably the same as that found in 1879 by M. de Lacaze-Duthiers at Frez-Hir, Finisterre.—On the optical properties of some fibrous minerals, and on some critical species (arseniosiderite, wawellite, vadiscite, davreuxite, hydrated anthophyllite, hydrotephroite of Langlan, Sweden), by M. A. Lacroix.

Berlin

Physiological Society, November 27, 1885.—Dr. Benda spoke on mammalian spermatogenesis. The results recently communicated to the Society by Dr. Biondi (NATURE, vol. xxxii. p. 544), of his investigation into the genesis of spermatozoa, had, in view of their divergence from the ideas of earlier observers, induced Dr. Benda to examine the subject more closely. By application of the best hardening and staining methods he had obtained precisely the same figures as had all earlier observers. In particular, through the preparations he had made from rats, bulls, and dogs, he had convinced himself of the actual existence of Ebner's spermatoblasts. Upon a large cell arising from the wall of the canal, the foot-cell, a thin stalk projects, on which was situated an oval formation consisting of small flaps. In his interpretation of this stalk, however, Dr. Benda differed from Ebner, taking the spermatoblasts as he (Dr. Benda) did, for a heap of daughter-cells connected by the stalk with the foot-cell. He further deviated from earlier observers in assuming that the foot-cell originated from a large wall-cell provided with a quiescent nucleus, which interiorly developed a process with which the daughter-cell then united into the spermoblasts. Not till later on did the spermatozoa appear. Examinations of a large series of different kinds of animals would enable a plan to be taken of all the stages of spermatogenesis.—In the discussion which followed the address, Prof. Waldeyer urged that the type of the spermatogenesis, as described by Dr. Biondi, namely, that of cell-columns with progressive development from the interior outwards of the spermatozoa out of cell-nuclei, proved conclusively in the case of the rat, might possibly not hold good for all kinds of animals. It was possible that in other kinds of animals the several stages passed, not successively, but simultaneously and less distinctly, one from another, so that whole knots of cells may be involved in the same stage of development. A subsequent conjunction of daughter-cells with the process of a foreign cell seemed to him improbable.—Dr. Müllenhof presented a series of photographs of horses in movement, prepared by Herr Anschütz in execution of a commission from the Royal Ministry of War. One series exhibited the successive positions of the horse in the act of springing; another in the act of trotting. Dr. Müllenhof followed this up with some observations on the way in which these images were obtained, and drew special attention to certain positions in the body of the animal.—Dr. Wolffberg described a case of abnormal single vision which had recently come under his observation. A man of sound health in every respect complained that for some time he was constantly seeing two objects of the same kind, or very similar to each other, as a single object when they were lying beside each other. It made no difference what was the form of the objects, whether they were letters of the alphabet, numbers, strokes, crosses, and so on. In all these cases he saw the two objects constantly as a single object when they stood at a short distance from each other. In a horizontal position the two objects might be placed at a greater interval from each other than in a vertical position, in order to be seen by him as a single object. The position of the singly seen image was always that of the fixed object. The single seeing of two objects was confined to the macula lutea. If the objects were not entirely alike, but only very similar to one another, then did they likewise appear as one. If they had different colours, then were they likewise seen as one object with rivalry of colours. In the eyes of the patient the existence of no objective anomaly could be established. By way of explanation of this hitherto unobserved phenomenon, Dr. Wolffberg called to mind the physiological phenomena of normal single seeing in the case of two images striking identical spots of the retina, and of abnormal single seeing in the case of objects in the circle of vision which did not indeed hit identical spots of the retina, but yet appeared as single. The physiological abnormal single seeing in this latter case respected, however, only objects to which attention was not turned, which were not fixed, and in such contingency the images appeared always between the two objects. If, then, the physiological single seeing, in the case of non-identical spots of the retina being hit, distinguished itself so far from the above-mentioned pathological condition, it yet had in common with the pathological condition the rivalry of the colours, the single seeing of similar objects, and the greater interval in horizontal than in vertical directions. In the opinion of the speaker, the observed pathological condition was due to a psychical cause, and was to be classed in the category of illusions.

BOOKS AND PAMPHLETS RECEIVED

"Le Sens des Couleurs chez Homère": Dr. de Keersmaecker (Lebèque, Brussels).—"Die Lebendige Kraft und ihr Mass": Dr. Max Zewerger (J. Lindauer, München).—"Widerstand und Maschinenleistung der Dampfschiffe": E. Rauchfuss (Lipsius und Tischer, Kiel).—Electro-Deposition": A. Watt (Lockwood and Co.)—"A Guide to the Examination of the Nose": E. C. Baber (Lewis).—"Alkali Tables," 2nd Edition: O. Bell (Lockwood and Co.).—"Practical Introduction to Chemistry": W. A. Shenstone (Rivingtons).—"Attack and Defence as Agents in Animal Evolution": C. Morris (Philadelphia)—"Les Orages en Russie": A. Klossovsky (Odessa).—"On a New Zealand Fungus that has of late become a Valuable Article of Commerce" W. Colenso.—"The Apparent Movements of the Planets": W. Peck (Archibald and Peck, Edinburgh).—"Beobachtungen über die Dämmerung insbesondere über das Purpurlicht und seine Beziehungen zum Bishop'schen Sonnenring": Dr. A. Riggenbach (Georg's Verlag, Basel)

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THURSDAY, FEBRUARY 18, 1886

PRACTICAL BACTERIOLOGY

An Introduction to Practical Bacteriology, based upon the Methods of Koch. By Edgar M. Crookshank, M.B. (Lond.), F.R.M.S., Demonstrator of Physiology, King's College, London. (London: H. K. Lewis, 1886.)

THIS excellent work is based upon notes made in different Continental laboratories, and is intended to be a laboratory hand-book as well as a text-book of bacteriology, including as it does "a systematic sketch of the genera and species of micro-organisms, as well as the methods employed in the investigation of their life-histories." The science is intimately connected with the etiology of the infectious and contagious diseases, and by enlarging knowledge as to the origin, causes, and spread of these diseases, has greatly aided, and may be expected in the future greatly more to aid, in the acquisition of knowledge as to the measures necessary to be adopted for their prevention; nevertheless it has received attention in this country from but a few earnest inquirers, the great mass of information now at our disposal having been accumulated in Germany. This fact is apparent at once on glancing through the pages of this book; for every English work, six German at least are referred to as having been consulted by the author. Apart also from its association with medical pathology, the subject is of the greatest interest to the naturalist, be he botanist or zoologist. It is only necessary to refer to the work of Pasteur in this connection for a proof of the vast amount of benefit to commerce and science which may still be anticipated to arise from a fuller knowledge of the life-histories of those organisms which are associated with so many diseases of plants, animals, and men. The importance of a study, not merely of the pathogenic or disease-producing, but of all the different species of Bacteria and Fungi is fully grasped by the author in the following paragraph: "It is impossible, by localising one's knowledge to pathogenic species to thoroughly understand the life-history of these particular forms, or to be able to grasp and appreciate the various arguments and questions that arise in comparing their life-history with the progress of disease."

The postulates formulated by Koch for establishing the exact relationship, and ascertaining beyond question whether a micro-organism associated with disease is actually the cause of that disease, are quoted by the author in the introductory chapter, and bearing as they do so intimately on the controversies which have raged over the relations of micro-organisms to disease, especially of Koch's comma-bacilli to Asiatic cholera, may be given here. They are as follows:—(*a*) The micro-organism must be found in the blood, lymph, or diseased tissues of man, or animal, suffering from, or dead of, the disease. (*b*) The micro-organisms must be isolated from the blood, lymph, or tissues, and cultivated in suitable media, *i.e.* outside the animal body. These *pure cultivations* must be carried on through successive generations of the organism. (*c*) A pure cultivation thus obtained must, when introduced into the body of a healthy animal, produce the disease in question. (*d*) Lastly, in the inoculated animal the same micro-organism must again be found.

The first part of the work is devoted to a description of the "apparatus, material, and reagents employed in a bacteriological laboratory"; to the methods employed for the "microscopical examination of Bacteria in liquids, in cultivations on solid media, and in tissues"; to the "preparation and staining of tissue sections"; to the "preparation of nutrient media and methods of cultivation"; to the subject of "experiments upon living animals"; and to the method of "examination of animals experimented upon, and the methods of isolating micro-organisms from the living and dead subject."

The multiplicity and complexity of the apparatus, materials, and reagents required for this work, and the great care and nicety in manipulation necessary for its proper execution, may well dismay the scientific inquirer who wishes to make a practical study of the subject. The expense alone of fitting up a laboratory on the lines indicated by our author, must form a great obstacle in the path of the would-be student. The license to experiment upon animals which would be necessary for a thoroughly systematic investigation is, as is now well known, most difficult to obtain. And yet there is no laboratory in this country at which such investigations could be undertaken by any one at a moderate expense. Surely London is rich enough, and earnest enough in the cause of sanitary progress, to found an establishment on the model of the Hygienic Laboratory at Berlin. There is fortunately no lack of men, thoroughly capable of undertaking its supervision, and its popularity and usefulnesy would not be a matter of doubt to those who are acquainted with the work of the Biological Laboratory at the Health Exhibition of 1884.

Part II. is "systematic and descriptive, with special microscopical methods," and commences with the history of our knowledge of Bacteria, the difficult question of classification being also here dealt with. In 1872 Cohn published his first classification. He considered the Bacteria to be a distinct group belonging to the Algæ, but from the absence of chlorophyll allied to the Fungi, and divided them into four tribes according to their shape, as globules, short rods, long rods, and spirals, these four tribes including six genera. In 1875 Cohn, in answer to Billroth, who disputed the division into species, considering that all the forms described by Cohn were but developmental forms of one organism, *Coccobacteria septica*, propounded a second classification, in which he still maintained that distinct genera and species existed. The genera Cohn considered to be distinguished by definite differences in shape, which were adhered to throughout life, while some special feature, as a difference in size or physiological action, or some minute difference in form, determined the various species. "Researches," writes our author, "by competent observers have quite recently clearly demonstrated that several micro-organisms in their life-cycle exhibit successively the shapes characteristic of the orders of Cohn. This had as early as 1873 been observed by Lister in a Bacterium in milk. Lister detected forms of Cocci, Bacteria, Bacilli, and Streptothrix genetically connected." Recent observers also have obtained similar results, so that the very foundation of Cohn's classification has been shaken, and "we are left without possessing a sound basis for classification into genera or species. The mode of reproduction is not sufficiently known to afford a better means for distinction than the other morphological appearances taken alone; nor can we depend upon physiological action, which is held by many to vary with the change of form according to altered surroundings." We have the authority, however, of Koch and Klein for believing that a Bacillus cannot change its nature, and be converted from a harmless into a pathogenic form, as asserted by Büchner.

It is usual now to regard Bacteria, yeasts, and moulds as constituting a class, the *Achlorophyllous Thallophytes*, divided into three orders: (1) *Schizomycetes* (Bacteria or fission-fungi); (2) *Saccharomycetes* (yeast-fungi); (3) *Hyphomycetes* (mould-fungi). Zopf, who, we learn, has warmly supported the pleomorphism of Bacteria, has suggested, as a result of his investigations, a division of the *Schizomycetes* into the following four groups: (1) *Coccaceæ*; (2) *Bacteriaceæ*; (3) *Leptothricheæ*; (4) *Cladothricheæ*. This classification is adopted by the author, but only as a provisional arrangement, pending increase in knowledge. "In determining," he writes, "the distinctions into species, we must take into account, not only microscopical appearances of the micro-organisms themselves, and their physiological actions, but the character of their colonies in plate cultivations, under a low power of the microscope, and the macroscopical appearances displayed in the various nutrient media. In this way, by considering each individual characteristic, Koch showed that the comma-bacillus of Finkler was a different organism from the Bacillus which was present in Asiatic cholera."

Group I., the *Coccaceæ*, are divided into five genera. Genus 1, *Streptococcus* (chain-cocci), includes the cocci found singly or in chains in acute abscesses; the cocci occurring in chains in the lymphatic channels of human erysipelatous skin, and in the fluid of erysipelatous bullæ, which produce typical erysipelas when re-inoculated in man and animals; cocci found in diphtheritic membranes and the surrounding tissues, and described as characteristic of this disease (but a Bacillus and a Bacterium have also been described as the specific micro-organisms of diphtheria); cocci of vaccine lymph, of which they are regarded as the active principle, since filtration deprives the latter of its infectious element, and successful vaccination has been stated to result from artificial cultivations. Numerous other forms are also included in this genus. Genus 2, *Merismopedia* (plate-cocci), includes *Coccus gonorrhææ* and *Micrococcus tetragonus*, pathogenic to mice. Genus 3, *Sarcina* (packet-cocci), includes *Sarcina ventriculi*, a coccus occurring in the stomach of man and animals; *Sarcina lutea*, a non-pathogenic form; and some other forms. Genus 4, *Micrococcus* (mass-cocci), includes the coccus of yellow pus, which is also the specific organism of acute infectious osteo-myelitis, a destructive disease of the marrow of bones; the coccus of blue pus; the coccus of fowl-cholera; *Micrococcus prodigiosus*, a harmless organism which produces a blood-red colour when cultivated on potatoes; the micrococcus of septicæmia and that of pyæmia in rabbits, and numerous other forms. Genus 5, *Ascococcus* (pellicle-cocci), only one form known.

Group II., *Bacteriaceæ*, is divided into six genera. Genus 1, *Bacterium* (cocci and rods, or only rods, which are joined together to form threads; spore-formation absent or unknown), includes the *Bacterium aceti* which causes the conversion of alcohol into vinegar; the bacterium of croupous pneumonia, occurring in pneumonic exudations, which by inoculation can produce the disease in mice. Genus 2, *Spirillum* (threads screw-form, made up of rods, or of rods and cocci; spore-formation absent or unknown). In this genus is contained the spirillum of Asiatic cholera—curved rods or commas, spirilla, and threads. The commas occur isolated or attached to each other, forming S-shaped organisms or longer screw-forms, and are found in the superficial necrosed layer of the intestines, in the mucous flakes and liquid contents of the intestinal canal of cases of Asiatic cholera. They were also detected by Koch in India in a tank used to supply drinking-water. Their development is arrested by deprivation of air, and they are destroyed by drying and various antiseptics. The results of their injection into the duodenums of guinea-pigs, said to have produced choleraic symptoms, have been by others asserted to have been due to septicæmic poisoning. The difference in appearance produced by pure cultivations in gelatine-peptone broth of Finkler's comma-bacillus and Koch's cholera-bacillus are very well illustrated, and the differences in growth of these two spirilla in other media carefully described. Finkler's bacillus or spirillum has been discovered in the evacuations of cases of cholera nostras, and has been shown quite recently to be also pathogenic. In this genus is also contained the spirillum of relapsing fever, observed in the blood of patients suffering from relapsing fever, but present only during the relapses. Monkeys have been successfully inoculated from cases of the disease in man. Genus 3, *Leuconostoc* (cocci and rods; spore-formation present in cocci), contains the frog-spawn fungus, which occurs occasionally in beet-root juice, and the molasses of sugar-makers, forming large gelatinous masses resembling frog-spawn. "The vegetation is so rapid that 49 hectolitres of molasses, containing 10 per cent. of sugar, were converted within twelve hours into a gelatinous mass; consequently it is a formidable enemy to the sugar manufacturers." Genus 4, *Bacillus* (cocci and rods, or rods only, forming straight or twisted threads; spore-formation present either in rods or cocci), includes *Bacillus subtilis*, the hay-bacillus, occurring widely in air, water, and soil; *Bacillus anthracis*, or bacillus of splenic fever in cattle, and of woolsorter's disease or malignant pustule in man, of which a very full and descriptive account is given, its morphological and biological characteristics having been very completely worked out. This disease, anthrax, is one of those in which Pasteur has succeeded in attenuating the virus so as to produce a "vaccin" capable of conferring immunity on animals after inoculation. The *Bacillus tuberculosis* also belongs to this genus. The numerous methods of preparing and staining the bacilli are fully described. The bacillus of blue milk, the bacillus of malignant œdema in mice, and that of septicæmia in mice, the bacillus of typhoid fever, observed in inflamed Peyer's glands, in the spleen, mesenteric glands, and the lungs in fatal cases of typhoid fever, but not as yet imparted to animals by inoculation, the bacillus of leprosy, the bacillus of malaria, the bacillus of glanders, and some others, complete a class of micro-organisms of the greatest importance from the number of pathogenic forms it contains. Genus 5 is the *Vibrio* of ordinary putrefaction; screw-form threads in long or short links; spore-formation present. Genus 6, *Clostridium* (same as bacillus, but spore-formation takes place in characteristically enlarged rods). In this genus are the bacillus of butyric acid fermentation, which converts the lactic acid of milk into butyric acid, and produces the ripening of cheese, and the clostridium of symptomatic anthrax, the cause of "black-leg" or "quarter-evil" in cattle.

Group III., *Leptothricheæ*, contains the following genera: (1) *Crenothrix* (threads articulated, cells sulphurless, habitat water), occurring in wells and drain-pipes. (2) *Beggiatoa* (threads unarticulated, cells with sulphur-granules, habitat water), of which the best-known is *Beggiatoa alba*, or the "sewage fungus," found in sulphur-springs and marshes, as well as in sewage-polluted streams. (3) *Phragmidiothrix* (threads jointless, successive subdivision of cells is continuous, cells sulphurless, habitat water), found attached to crabs in sea-water. (4) *Leptothrix* (threads articulated or unarticulated, successive subdivision of cells not continuous, cells sulphurless), found in carious teeth.

Group IV., *Cladothricheæ* (possessing cocci, rods, threads, and spirals: thread-forms provided with false branchings), contains *Cladothrix dichotoma*, said to be the commonest of all Bacteria in both still and running water, in which organic substances are present.

Amongst species of Schizomycetes mentioned by writers, and not described or not recognised as distinct species in the preceding classification, are *Micrococcus indicus*, *Micrococcus septicus*, *Micrococcus endocarditicus*. The micrococci of measles, scarlatina, cerebro-spinal meningitis, typhus, acute yellow atrophy of the liver, whooping-cough, puerperal fever, gangrene, yellow fever, dental caries, and saliva. Most of these organisms are only known to be associated with the diseases in question, the causal relations, if existent, have yet to be determined. In this chapter are also described *Bacterium termo* of common putrefaction, *Bacterium lactis*, *Bacillus figurans*, the bacillus of swine fever, the bacillus of choleraic diarrhœa from meat-poisoning, the bacilli of septicæmia in man, of syphilis, and of rhinoscleroma, the comma-bacillus of the mouth, various forms of spirillum and monas, *Proteus vulgaris*, described as intimately connected with the process of putrefaction, *Actinomycetes*, said to be the cause of actinomycosis, a disease of the jaws and lungs in men and animals, and many others too numerous to mention.

An appendix is devoted to the consideration of the yeast-fungi, or *Saccharomycetes*, and of the mould-fungi, or *Hyphomycetes;* under the latter are described the various species of *Mucor*, *Oidium*, *Aspergillus*, &c. The volume concludes with an account of Koch's methods for the examination of air, water, and soil, with a view to the detection and recognition of their contained micro-organisms.

Enough has probably been said to show the wide range covered in this work and the full and able manner in which its matter has been treated. On the importance of the subject and the want that has been supplied by the production of a work that has condensed into one volume a subject, the literature of which in English is diffused in numerous reports and periodicals, we have already remarked. The numerous coloured plates of test-tube and potato cultivations and those of microscopic appearances are admirably designed and executed, and greatly enhance the value of the work.

The book, we believe, will be widely read and appreciated by all interested in science.

THE ANATOMY OF THE NETTLE

*Recherches anatomiques sur les Organes végétatifs de l'*Urtica dioica, *L.* By A. Gravis. (Brussels, 1885.)

A WORK of more than 250 pages devoted exclusively to the anatomy of the vegetative organs in one species of nettle is a publication of a somewhat unusual kind, even in these days of scientific specialisation. The author has evidently bestowed a vast amount of labour on his subject. He states in his introduction that no less than 15,000 sections had to be made in the course of his investigation of this one plant, and twenty-three beautifully executed plates bear witness to the laborious accuracy with which the work has been carried out. The treatise is one which hardly admits of an abstract, as in a monograph of this kind details are everything. We shall only attempt to give a sketch of the order in which the author has arranged his facts, and to indicate one or two points on which his conclusions have some general interest.

The investigation was originally intended to serve as a basis for a general comparative study of the family Urticaceæ. The question of the value of anatomical characters in classification is one which has engaged the attention of many botanists during the last few years. So far the results have proved of very unequal importance in different cases. The author notices the much more considerable part played by anatomy in zoological than in botanical classifications. This he attributes in a great degree to the frequent neglect on the part of botanists to examine every part of the plant in question, at all ages, and under varying biological conditions. Too often one or two sections are made, almost at haphazard, from each species, with the result that things not truly comparable are frequently compared. One of the main objects of the work before us is to show how great the variations are which are due to the differences just mentioned.

The treatise is divided into three parts, devoted respectively to the stem, the leaf, and the root. The first part begins with a general account of the external conformation of the stem of the nettle, and its systems of subaërial and subterranean branches. For the purposes of his exposition the author divides the stem into *segments*, each segment including a node, with the lower half of the internode next above it and the upper half of that next below it. He then proceeds to classify the variations of structure investigated. First he distinguishes variations *according to level*, by which he indicates the different structures shown by transverse sections of different parts of the *same* segment, the most important of these differences being those between the nodal and internodal structure. Next come variations *according to age*, namely, those which are presented by corresponding sections taken at different periods of development. The third class of variations are those *according to height*, that is to say, those shown by corresponding sections of *different* segments of the stem. Fourthly, and lastly, we have variations *according to the biological conditions.*

The first chapter contains a detailed account of the structure of "segment I" of the principal stem, *i.e.* the segment including the node next above the cotyledons. In the succeeding chapters the anatomy of the segments superior to segment I, and the development of an apex of large diameter are treated of. The fourth chapter deals with the hypocotyledonary axis, under which term the radicle of the embryo is included.

The second part treats in a corresponding manner of the leaf, only here the cotyledons first receive attention, then the leaves next above them, and so on. The increasing complication of structure along the sub-aërial stems, and the converse degradation along those which are subterranean, form the subject of a special chapter.

In the third part the variations in the structure of the root according to age and height are considered, the subject of apical development having a chapter to itself.

The method of successive transverse sections was used throughout the investigation.

The author compares the constantly increasing complexity of the successive segments of the principal stem to an accelerated movement, the amount of the acceleration varying according to the biological conditions. This strikes us as a neat mode of expression.

The author's account of the progress of secondary thickening in the stem is interesting, especially the observation that in the lower segments cauline plates of vascular tissue of secondary origin occupy the same position as that assumed by additional primary bundles in the more complicated segments above them. This and similar facts lead the author to a generalisation which he expresses in a phraseology adapted from Haeckel's famous law, namely, that "the organogeny of the stem repeats its ontogeny."

We must enter a protest against the use of the word "cambiform" for cambium which gives rise to secondary fundamental tissue. The word cambiform has long been used for certain cells of the phloëm-parenchyma, and we already have quite ambiguities enough in the use of the word cambium and its derivatives.

The work concludes with the expression of the author's conviction that vegetable comparative anatomy demands a knowledge of the structure throughout the whole extent, and at all ages of the plant. A formidable task is thus imposed on the anatomists of the future. D. H. S.

OUR BOOK SHELF

Magnetism. By Willoughby Smith. (London: November, 1885.)

A PECULIAR pamphlet, said to be compiled for the instruction of the electrical staff of the Telegraph Construction and Maintenance Company, but issued gratis by the author, and devoid of any publisher. It commences with a novel version of the story of the shepherd of Mount Ida, who is given not only a local habitation, but a name, and it ends with a material notion of lines of force which will startle some of our readers. Moreover, electrical discharges, magnetic clicks, &c., are "caused by the lines of force adjusting themselves to each other." It contains nothing new of magnetism, but it promulgates some strange notions. "The Great Architect of the universe employs no rectilinear motions or angles." "Each atom of matter possesses in itself all the properties of a magnet, and emits its own lines of force." "All particles of matter, solid, liquid, or gaseous, are in a polarised state, and consequently emit lines of force." "The (electrical) conducting properties are the result of forced polarisation." "Each atom composing our atmosphere is in a state of polarisation, and is influenced by the magnetic force emanating from the earth." "The force which is called gravity is the effect of such an universal system of polarisation, with which God has endowed all matter." "Iron is very susceptible of polarisation from the effects of what is called terrestrial magnetism (the polarised atoms of the air)."

These extracts are enough to show the tenor of the paper, which will not enhance Mr. Smith's reputation. He has evidently not read Airy's "Treatise on Magnetism," where it is laid down that terrestrial magnetism is not produced in any important degree by magnetic forces external to the earth, and it does not even reside on the earth's surface. Its source must lie deep. The apparatus and experiment given at p. 29 are detailed more fully and clearly in Thompson's "Dynamo-Machinery," and that at p. 41 would be more elegantly obtained by Hughes's induction-balance. It is curious that no reference should be made to the labours of Sturgeon, Scoresby, W. Thomson, and Hughes, and that the laws of Lenz, Jacobi, Dub, Müller, and others are ignored. It is not a pamphlet on magnetism, but a vehicle for the promulgation of certain individual ideas, which it is to be hoped will not take root among those who have been favoured with the gift of this well-printed *brochure*. Indeed, its *raison d'être* is shrouded in mystery.

An Introduction to the Osteology of the Mammalia. By Wm. H. Flower, LL.D. Revised with the assistance of Hans Gadow, Ph.D. Third Edition. (London: Macmillan and Co., 1885.)

WHEN Prof. Flower published, in 1870, the first edition of his "Introduction to the Osteology of the Mammalia," the student at once recognised that he had been supplied with a text-book of convenient size and form, which furnished him with an admirable introduction to Mammalian osteology. The appearance of a second edition of this book in 1876, and of a third edition at the end of last year, are renewed evidence of the usefulness of the work, and that it continues to be appreciated by those who are engaged in the study of the anatomy of the Mammalia.

This edition has been revised throughout, and we notice in it many alterations and additions. The most important change is in the chapter "On the Classification of the Mammalia," which appropriately precedes the purely descriptive part of the book. This chapter has practically been rewritten, and embodies the introductory observations which the author has given to his important article "Mammalia," in the ninth edition of the "Encyclopædia Britannica." A very useful table has also been introduced in connection with the chapters on the vertebræ, which the author has compiled from his Catalogue of the Mammalia in the Museum of the Royal College of Surgeons of England. This table gives the number of the vertebræ situated in each region of the spine in the skeletons of about 350 mammals, and is the most complete record of the kind which has yet been prepared.

In this, as in the preceding editions, the dog's skull has been taken as that from which the general description of the Mammalian skull has been written, and with which the study of the skull may appropriately be commenced, and its description has not been changed; but in addition a useful abstract of our present knowledge of the development of the skull has been drawn up from Balfour's "Treatise on Comparative Embryology."

We have observed also a number of short but useful additions and emendations in the descriptions of various of the bones, so that the present edition exceeds the last by thirty-eight pages. The illustrations also have been increased by the insertion of eight more woodcuts. We wish to give a hearty recommendation to all students of the Mammalia, to use this new edition of a book, written by the anatomist who is admittedly one of the highest authorities on their structure.

Catalogue of the Fossil Mammalia in the British Museum. Part II. Artiodactyla. By Richard Lydekker, B.A. (London: Printed by order of the Trustees, 1885.)

MR. LYDEKKER published in January 1885 the first part of the Catalogue of Fossil Mammals in the British Museum, and in it he recorded the specimens belonging to the Orders Primates, Chiroptera, Insectivora, Carnivora, and Rodentia. He has rapidly followed this up by the preparation of the second part, containing the sub-order Artiodactyla of the great Order Ungulata. The Natural History Department of the British Museum is remarkably rich in specimens of this sub-order, and though in the Catalogue, in the larger number of instances, only the briefest possible description of each specimen is given, yet the volume has reached 324 octavo pages. The collections, in addition to those enumerated in the first part, which have furnished specimens, are the Bowerbank, Layton, Sloane, and Wigham collections. The author points out that he has employed generic terms in a wider sense than is the case with many writers. Thus he does not regard a difference of one or more premolar teeth, or in the number of digits, in allied forms, as a bar to generic unity, and accordingly he includes the genus *Eurytherium* in *Anoplotherium*. The Catalogue has been compiled with the care which distinguishes the catalogues of our great national Museum.

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

On "Seter," or Parallel Roads

I SEE to my great vexation that in my former letter on parallel roads (NATURE, January 21, p. 268) I have made a rather hideous blunder in my English to the great disadvantage of the clearness of my theory. I have used the French-German-Norwegian term "rest" as signifying *le reste*. My theory is that the last "rest," *i.e.* residue, of the inland ice formed a great dam somewhat seaward from the watershed; I do not refer to any "rests," *i.e.* reposes, in the great ablation.

It is a fact that the glacier-shed in Central Norway was situated as far as 150 kms. to the south or east of the watershed. The direction of the striæ and the boulder-transport renders this indisputable. By the melting of the ice I now suppose that the last remains must have lingered near the glacier-shed. We find the last residue far to the south of the watershed. I cannot find with Mr. Melvin that this idea reverses the order of Nature. The precipitation and temperature in Christiania and in Trondhjem now differ very inconsiderably, and the difference in height between the former glacier-shed and the watershed is not very great, while the distance from this to the sea is five times as great to the south as to the north.

This residue now in all valleys dams up lakes to the cols; in these lakes the terraces of gravel with laminated clay are built up; and on their shores the *seter* or parallel roads are formed. Nothing is simpler.

When I first got this conception I only knew the Österdal (and Lochaber) *seter*, but I concluded that parallel roads and inland terraces were to be expected in all valleys where the striæ proved that the glacier-shed lay seaward to the watershed. I next found some notice of such formations in the neighbouring valleys Gudbrandsdalen in Norway, and Herjedalen in Sweden. Having already finished my paper, I got a dissertation of Högbom in which, as expected, Jemtland was included in my *sete* region. In my letter to NATURE I further inferred that parallel roads must needs exist in Swedish Lappmark. This conclusion has also since proved to be correct. Dr. Svenonius has found a *sete* at Sitasjaur: the correlation of striæ going upwards against the drainage with terraces and parallel roads at a height corresponding with the cols. This is established between 61° 40′ and 68° in Scandinavia as well as at Lochaber. Nowhere else are parallel roads known in Europe. This local geographical distribution is perhaps the best argument for my theory of lakes dammed up by the gradually diminishing residue of the inland ice situated at a distance from the watershed, near the former glacier-shed.

Mr. Melvin's theory of lateral moraines was also my original working hypothesis; but it gives no explanation of the great terraces which are connected with the parallel roads, nor of the laminated clay (with Desmidieæ) in the terraces as well as in the *sete* itself. Any one who has walked for kilometres on a *sete*, smooth as a road, without any variation of the aneroid (the greatest difference in Lochaber is 4 metres), will hardly be able to dismiss the idea of a water-level. How Mr. Melvin will account for the alternating shelves *cut in the rock* I cannot see.

ANDR. M. HANSEN

University Library, Christiania

P.S.—Errata in my former letter: p. 268, col. 2, line 11, for "280 kms." read "150 kms."; line 30 from bottom, for "till" read "tell."

Mimicry in a Neuropterous Insect

I HAVE been much struck by a somewhat complex form of mimicry in a neuropterous insect of the genus Mantispa, which would not be suspected if only a cabinet specimen were seen, with the wings extended motionless, with its raptorial fore-legs folded in front of the head. The insect, as I observed it, was on the bare whitewashed wall of a house at Delhi, exposed to the afternoon sun. As I then believed it to be a dipterous insect feeding on some substance stuck to the wall, it is probable that its prey, most likely the common house-fly, would be similarly deceived, and, being attracted to the spot in hopes of sharing the food, would fall a victim.

The prothorax is curiously modified, both in colour and shape, so as to resemble a proboscis, while the head and fore-legs are so compactly folded that they look like some solid substance adherent to the wall or stone on which the insect is resting, and not part of the creature itself. The mesothorax has two eye-like spots shaded so as to simulate the reflections of light from the compound eyes of an insect, while the markings of the abdomen, seen through the transparent wings, are very dipterous in character.

The points where the Mantispa seems to fail in its likeness to a fly are in the size of the prothorax, which is more massive and thick than the proboscis of any fly; there is a want of prominence in the mesothorax representing the fly's head; the venation of the wings is different; and, lastly, there are apparently only four legs instead of six.

These faulty points are seen at once on a minute inspection; but it may be imagined that it is only necessary to attract the attention of a fly passing at some distance, and convey a certain mental impression, which in the simple mind of a fly may not be effaced till the desired object has been attained, and the victim brought within reach of the Mantispa's arms.

The resemblance between the fore-legs of the praying Mantis and the same organs in Mantispa is remarkable when it is remembered that the two insects belong to different natural orders. The fore-leg of Mantispa is the more specialised, and has great lateral motion, while the edges of the femur are armed with teeth slightly blunt at the tips, so that the captured insect can be shifted if necessary. The joints in the same limb in the Mantis are simple hinges, and both the femur and tibia are fringed with a double row of very sharp spines, which are necessary to pierce and retain a hold on the thin unsubstantial wings of a butterfly which the Mantis patiently waits for, perched on the top of some conspicuous head of flowers.

Simla, January 17 E. R. JOHNSON

Fabry's Comet

ON the 6th inst., with a power of 38 on a $4\frac{1}{4}$-inch refractor, I observed that this comet had a distinct, though very faint, tail, at a position-angle of about 85° ; length $13\frac{1}{2}'$. The radius of the coma was about 3'. I thought I could see the tail on the 1st inst., but was not quite sure of it then. The comet's spectrum strikes me as less distinct than is the case with most comets. On the 1st inst. I could only see two bright lines (or bands) certainly ; and the less refrangible of these was very faint. I suspected a third band towards the more refrangible end of the spectrum. T. W. BACKHOUSE

Sunderland, February 13

Mist-Bow

ON the Wiltshire Downs, near Marlborough, at about 4 o'clock on February 10, I observed a white mist-bow, in position and shape resembling the rainbow, but pure white, and the arc was of considerable width throughout, estimated at 5°–10°, altitude of the sun 15°–20°, altitude of the summit of the bow 35°–45°. The wind was slight, and there was a frost at the time, and a thick deposit of rime on the trees, &c. Has this been observed elsewhere or explained? Is the phenomenon due to the superposition of coloured bows, or to the polarisation of the semi-crystallised vapour composing the fog? A. E. E.

Movement of Telegraph-Wires

THERE can be no doubt that Mr. Mountford Deeley correctly attributes the rotatory oscillation of the wires during frost to the air-current acting upon a "wing" of ice-spicules. I described this phenomenon in *Science Gossip*, 1874, p. 254, and explained the cause of it in NATURE, vol. xxiii. p. 338.

Birstal Hill, Leicester F. T. MOTT

HENRY BRADSHAW

UNFORTUNATELY it far too often happens that there seems to be an impassable gulf fixed between the man of letters and the man of science, which hinders the one not only from partaking in, but even from appreciating, the ideas, the objects, and the methods of the other. There is no need, especially here, to impute blame to either; but when a man of letters is found who, modestly making not the least pretension to scientific knowledge, yet sympathises deeply with the man of science, some acknowledgment of the fact seems to be due. Such an instance there was in Mr. Henry Bradshaw, Senior Fellow of King's College, and Librarian of the University, whose sudden removal Cambridge is now mourning. Of his literary ability, his bibliographical accuracy, his mastery of one important period of English poetry, and his knowledge of early printed books, this is not the place to speak. Justice to those qualities doubtless is being, or will in due time be, rendered by other writers, better fitted to pronounce an opinion upon them. But here may be appropriately recorded the enthusiasm—for no other word will suit—with which he at all times entered into and aided inquiries, investigations, and researches that most men in his position would have considered to lie entirely outside of their own, and as such to be without any dereliction of duty disregarded. His time, his energy, and his varied attainments were always at the disposal of any member of the University, whose servant, in the highest sense of the word, he rejoiced to be. But there was no need for any one to be a member of the University to obtain his help. Accessible at all times to all who sought him, the asking of a simple question was a sufficient introduction, and whether that introduction was only the prelude to an acquaintanceship which might speedily ripen into a friendship depended far more on the person who asked it than on himself. By the younger members of the University to whom he was known, and the number of them was vast, he was regarded with feelings of affection, that it would seem almost exaggeration to describe, and his influence over them, always tending towards the highest ends, was proportionately great. But here it is more fitting to dwell upon the active sympathy he showed with students of biology. His great intimacy with the late Mr. G. R. Crotch had led him to take an extreme interest in the literature of systematic zoology, and particularly in the precision which is required of those who pursue the branch of it relating to the Coleoptera, not that Mr. Bradshaw must be supposed to have had any knowledge of the subject. It was simply the method of accurate work which excited his admiration, and that method, he has more than once told the present writer, had largely influenced his own bibliographical investigations, the high value set upon which must be told by those whom they concern. Never taking offence, wholly free from pride, always ready to put the best construction on every man's conduct, catholic in all his feelings, Mr. Bradshaw passed away in his College rooms, apparently without any suffering, on the night of the 10th or morning of the 11th of this month—an end to be envied by most men. A. N.

THE COAL-DUST QUESTION

IN the last paragraph of my letter to NATURE (Dec. 31, p. 197), I stated that those who, having investigated the question of the influence of coal-dust in colliery explosions, had come to the conclusion that coal-dust is not, as a rule, the principal agent in an explosion occurring in a dry and dusty mine, appear to have omitted to take one important element of the case into consideration; and in saying so I implied that, if they had not made this omission, their conclusions in this respect would probably have been more in accordance with my own.

All the important experiments with coal-dust on a large scale have been made in wooden boxes or galleries of greater or less length, open at one end and closed at the other. The ignition or explosion has usually been begun at or near the closed end, and been propagated towards the open end, driving part of the contents of the gallery out into the air in front of it.

Certain conclusions in regard to colliery explosions have been drawn from the results obtained on this small scale which appear to ignore the fact that the conditions here prevailing are far less favourable to the propagation of the coal-dust flame than those which obtain in a mine at the instant an explosion is sweeping through it. For, it is obvious that in the former case the air is practically at *constant pressure* while the explosion lasts, whereas in the latter case it is practically at *constant volume* during the same period. But as the amount of heat required to raise the mixture of air and coal-dust to the temperature of ignition in the first case is greater than that required to effect the same result in the second case in the ratio of 1·41 to 1, it follows that an explosion having been once begun in either case will be propagated much more rapidly and surely in the mine than in the apparatus. Thus it is that a kind of coal-dust which produces comparatively feeble results in the apparatus may give rise to very disastrous consequences in the mine.

An illustration of this difference of behaviour under the two sets of conditions has been furnished by the dust of Camphausen Colliery in Germany. When subjected to the experimental test in the large apparatus at Neunkirchen, already described in these pages, it was found to be far down the list in point of relative danger, and was pronounced to be, like most of the other dusts in the same list above and below it, of a comparatively harmless nature. But when an explosion subsequently occurred in the mine, and traversed the whole length and breadth of the workings, which were known to be practically free from fire-damp at the time, producing the most disastrous effects, the fallacy of the conclusions drawn from the experimental results was rendered abundantly evident.

In the whole of my papers on this subject, and most pointedly in my last article on coal-dust explosions published in *Iron*, in the year 1878, I have carefully indicated that a difference was to be expected in the behaviour of dust ignited under the two conditions named. It has therefore been with feelings of considerable surprise that I have observed members of the French, English, and German Mining Commissions, and others who have investigated this subject since the publication of my first paper, one after the other pronounce some very decided opinions as to the relatively subordinate part which coal-dust plays in a colliery explosion, while at the same time they were neglecting to take into account this very simple and yet all-important element. W. GALLOWAY

VESUVIAN ERUPTION OF FEBRUARY 4, 1886

THE rent that was formed on May 2, 1885, in the upper part of the great cone (NATURE, vol. xxxii. p. 55) gave issue to lava until December 25. A small quantity again issued between January 2 and January 5, 1886, after which no more made its appearance till this new outburst. In consequence of the rise of level of the magma in the chimney, the cone of eruption has grown very much during the last month.

On February 4, at about 8 p.m., lava broke forth at the foot of the old crater ring of 1881-2 at a point bearing from the main vent about 10° W. of N., traversed the crater plain, which is here very narrow, in a somewhat oblique direction, and ran down the slope of the cone between north and north-north-east. The lava soon reached the foot of the cone, but even up till midday to-day, when I left the mountain, it had not yet commenced to cross the Atrio del Cavallo. The eruption took place from probably the same dyke that gave rise to that of January 9, 1884.

To-day, February 6, the lava bubbles up like a spring at the foot of a hill, and flows for some distance in a kind of trough which it has raised on each side of itself above the level of the crater plains. After a short distance it enters one of its own tunnels to reappear again at some distance. It was very interesting to watch its welling, and from time to time the bursting of a steam bubble as big as a bucket, which would throw up splashes against the imperfect arch at the immediate exit. These splashes partly adhered to the roof and partly fell, drawing out the suspended portion into irregular strings, illustrating the formation of the stalactitic lava that is so common in lava fumaroles.

The chloride crusts in the neighbourhood were uncommonly rich in copper, so that my boot-nails were thickly plated with that metal.

The lava makes its appearance at about 100 yards from its entrance in the tunnel near the main spring, although it is now divided into two streams. The eastern, which is the largest, is 1 metre broad; I plunged a stick in to the depth of 1 metre, but the shortness of the stick and the great heat prevented me from touching the bottom. The current ran at the rate of 1 metre per 6 seconds, which, making allowance for viscous drag at the edges and bottom, will give an output of at least 360 cubic metres per hour, or at least 17,280 cubic metres during the 48 hours up to 8 o'clock this evening. The more western stream was 50 centimetres broad, over 1·20 metres deep (as far as I could reach with my stick), and flowed at the rate of 1 metre in 8 seconds. Giving a loss of 2 seconds of speed from drag at sides and bottom, we have an output, for 48 hours, of 10,368 cubic metres. The two streams together would, therefore, have afforded, since the commencement of the eruption, 27,648 cubic metres.

As the altitude of the lateral outlet is much more than that of May 2, both on the night of the eruption and the following one, the volcano showed the *first stage of activity* as judged by the appearance of the main vent.

This winter the mountain has been covered by snow several times, and to-day it extends down nearly to the level of the Observatory. During our ascent we had to walk through a stratum of about 8 inches, though much thicker in the drifts. Two-thirds of the crater and part of the cone of eruption were also covered.

I should have sent news yesterday, but, on attempting an ascent, I was driven back by wind, rain, and mist.

Naples, February 6 H. J. JOHNSTON-LAVIS

TIDAL FRICTION AND THE EVOLUTION OF A SATELLITE

A PAPER by Mr. James Nolan has recently appeared which is devoted to an adverse criticism of my views concerning the effects of tidal friction as a factor in the evolution of the moon and earth.

The title of the pamphlet, "Darwin's Theory of the Genesis of the Moon,"[1] shows, I think, that the author has misconceived the scope of my work. It was not supposed that the investigation threw light on the actual mode of genesis of the moon, but was rather applicable to the subsequent history of the moon and earth. Mr. Nolan attributes to me views as to the condition of the moon immediately after her birth which do not appear a just interpretation of my writings, and although it might have been well to use more guarded expressions in some passages, the justice of his condemnation of the whole theory cannot be admitted. He sums up his case by the three following propositions:—

"(1) That the moon could not have existed bodily so near the earth as the greatest initial distance fixed.

"(2) That in any form possible there she could not have receded by the agency assigned—tidal friction.

"(3) That, if a modification be made by allowing her to have separated at a greater radius than that corresponding to a period between 2 and 4 hours, the moon would be no longer traceable to the earth's *present* surface on which condition the theory has been founded."

The first of these propositions is interesting, and I have to thank him for drawing my attention to it.

When a small satellite revolves about a planet with a certain proximity, the sum of the centrifugal and tidal forces may be such as to overbalance the gravitation towards the centre of the satellite. When this is the case, the satellite cannot exist as a single mass. The complete solution of the problem, concerning which Mr. Nolan adduces certain elementary considerations, is of extreme difficulty. At present I do not wish to go into this question, but shall consider the point on another occasion. It may, however, be admitted that the moon could not subsist as a single continuous body with its surface in contact with the earth.

On p. 4 he quotes a passage from the abstract of one of the papers (*Proc. R.S.*, No. 200, 1879), which must be surrendered; it is as follows:—

"The coincidence is noted in the paper that the shortest period of revolution of a fluid mass of the same mean density as the earth, which is consistent with an ellipsoidal form of equilibrium is 2 hours and 24 minutes; and if the moon were to revolve about the earth with this periodic time, the surfaces of the two bodies would be almost in contact with one another."

Now, since 1879 it has been shown by Sir William Thomson that the ellipsoidal form referred to could not

[1] Geo. Robertson and Co., Melbourne, Sydney, Adelaide, and Brisbane, 1885. Pp. 16.

subsist, because it is dynamically unstable. It does not, then, seem worth while to consider the remarks made on that passage.

With regard to the first proposition that, if the moon separated from the earth near the present earth's surface, it can only have subsisted as a flock of meteorites, my own words may be quoted as follows:—

"The planet then separates into two masses, the larger being the earth and the smaller the moon. I do not attempt to define the mode of separation, or to say whether the moon was initially more or less annular. At any rate it must be assumed that the smaller mass became more or less conglomerated, and finally fused into a spheroid, perhaps in consequence of impacts between its constituent meteorites, which were once parts of the primæval planet. Up to this point the history is largely speculative, for, although the limiting ellipticity of form of a rotating mass of fluid is known, yet the conditions of its stability, and *a fortiori* of its rupture, have not as yet been investigated. . . . At some early stage in the history of the system the moon has conglomerated into a spheroidal form."[1]

When, however, Mr. Nolan goes on to his second proposition, and states that this amounts to saying that the moon must have been a ring of fragments revolving in the plane of the equator, and that such a ring must be uniformly distributed and therefore incompetent to raise frictional tides, it is not easy to follow him. Is there any objection to the existence of a flock of meteorites? And would not such a flock raise tides in the planet which, if subject to friction, would introduce forces tending to make the meteorites recede? It seems that there is no such objection, and that the flock of meteorites would follow the same fate as the satellite when conglomerated in a single mass.

The difficulties which are raised by the author in the conception of the conglomeration are such as meet us in all evolutionary theories, and whether or not it is possible as yet to see our way mentally through the changes which may have taken place, yet it is generally admitted that conglomeration took place in some way.

He then points out that no other satellite is traceable up to the surface of its planet, and concludes that it is a coincidence that the masses and periods of the moon and earth are apparently such as fit into the theory. No one has pointed out the non-existence of such a satellite more clearly than I,[2] but the absence of reference to my work seems to show that Mr. Nolan has not looked at it. It is not then surprising to read: "Is it not very illogical to suppose that the moon originated in a way which cannot have been the way of origin for other planets and satellites?" And the reader of this sentence would hardly think that my position is that there is a probability that a cause which was subordinate in the history of the other planets was predominant in the case of the moon and earth, and that it is proved numerically that in the terrestrial sub-system the actual distribution of masses and momenta (the factors governing tidal friction) differs at least as much from the corresponding factors in the other planetary sub-systems as the supposed modes of evolution.

On p. 13 we read:—

"There is a law, according to which two heavenly bodies cannot revolve about their centre of gravity with their surfaces nearly in contact, unless one be smaller than the other by a certain amount, and, further, that the small one be denser than its companion by a certain value."

I do not know where to find the proof of such a law, and at the present moment am disposed to doubt its correctness.

[1] *Phil. Trans.*, part 2, 1880, pp. 830-81.

[2] "On the Tidal Friction of a Planet attended by several Satellites" *Phil. Trans.*, part 2, 1881).

Next, on p. 14, we find:—

"Rapid rotation would never cause a quantity of the matter of a body to become piled up at one particular place, and form into a separate single body there of any appreciable size."

Now very recently M. Poincaré has rigorously proved in a very remarkable paper[1] the possibility and even the dynamical stability of such a "piling up," and has given a sketch of the mode of separation of a portion of the mass of rotating fluid. In a paper of my own, now nearly finished, the same problem is treated, but from a different point of view.

It will be perceived from the quotations that the pamphlet is true to its title, and refers almost entirely to the genesis of the moon. This affords some proof that my speculative remarks hazarded as to the mode of origin of the moon, were not so guarded as was intended. The justice of the third of Mr. Nolan's propositions may, however, be denied, and certainly the theory cannot be held to depend on the genesis of the moon at the *present* surface of the earth.

The present opportunity will be convenient for a short reiteration of my point of view with regard to the whole subject.

In tidal friction we have a *vera causa* of modifications in the configuration of the earth and moon. If we adopt provisionally the hypothesis of an adequate lapse of time, we can trace the changes, and find that the obliquity of the ecliptic, the eccentricity of the lunar orbit, and its inclination to the ecliptic (all unmentioned by Mr. Nolan), the lunar periodic time, and that of the earth's rotation, are co-ordinated together by supposing that the moon first had a separate existence at no great distance from the present surface of the earth, and with small differential motion with respect thereto. Then it is maintained that this co-ordination is so remarkable as to give good reason for accepting the hypothesis as in accordance with truth. Concerning the earlier stage in which the moon may be supposed to have separated from the earth, nothing more than conjecture is possible, but undoubtedly the condition adduced by Mr. Nolan escaped my notice.

In examining the rest of the solar system, it is found that, amongst other things, the Martian satellites afford a striking confirmation of the influence of tidal friction, and that the system of the moon and earth presents features so distinct from those of the other planets, as to justify the belief that tidal friction, subordinate in its influence on the other systems, may have been predominant in our own. The theory is also found to throw light on the distribution of satellites in the solar system.

It is as yet too soon to say how far these views embody the truth, but even should they be found untenable, yet certainly the determination of the effects of tidal friction on a system of planets and satellites is a problem of physical astronomy which was well worthy of attack.

G. H. DARWIN

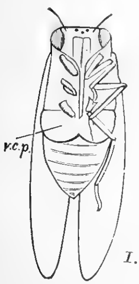
[1] *Acta Mathematica* (1885), 7, 3, 4, "Sur l'équilibre d'une masse fluide animée d'un mouvement de rotation."

ON THE SOUND-PRODUCING APPARATUS OF THE CICADAS

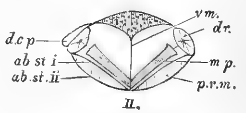
HAPPENING to refer to Prof. Jeffrey Bell's "Comparative Anatomy and Physiology" on the question of the sounds produced by insects, I read, with reference to the Cicadas:—"The sound seems to be produced by the vibration of membranes, placed on either side of the stigmata of the metathorax, and set in motion by the respiratory air" (p. 389).

As this wind-instrument theory of Landois seems to be supplanting, in our text-books and popular natural histories (*e.g.* Cassell's), the drum theory advocated by Réaumur and the earlier writers, I think it permissible to draw attention to certain observations I made on this subject some six years ago. They were published in the not readily accessible *Proceedings* of the South African Philosophical Society (1879-80, part iii. p. 161), and were not illustrated by any figure.

The Singerjie (*Platypleura capensis*) is a well-known and tolerably abundant insect at the Cape; and few visitors to the shores of Table Bay can have failed to notice, in the hotter months of the year, the sharp shrill metallic sound produced by the "little singer." It is soon found that the male Cicada alone possesses the power of singing, the female—recognised at once by the long ovipositor folded beneath the abdominal somites—being dumb. If the ventral surface of a male singerjie be examined (Fig. I.) two large ventral cover plates (*v.c.p.*) are seen, one on either side, meeting in the central line and extending backwards from the metathorax over the anterior abdominal somite. On turning the insect over and looking at the dorsal surface, two very much smaller dorsal cover plates are seen extending forward from either side of the first abdominal somite. If one of these plates be removed with fine pointed scissors, there is seen the wrinkled surface of a thickish chitinous membrane, the drum. Turning the insect over again, so as to examine more carefully the ventral aspect, and removing one of the ventral cover plates, two membranes are disclosed, separated by a transverse chitinous support. Of these the anterior is white, narrow, and opaque, the posterior (*p.r.m.*, Fig. II.) translucent, oval, and tightly stretched.



I.



II.

The transverse chitinous support (*ab.st.*i) is the sternum of the first abdominal somite; the membranes are intersternal membranes which would seem to be specially modified to act as resonators. The second ventral cover plate may now be removed, disclosing the anterior and posterior resonator membranes of that side; the anterior resonator membrane of each side may be cut through; and the abdominal portion of the insect may be separated from the thorax. When this is done there are seen, taking their origin from the mid-line of the first abdominal sternum (Fig. II., *ab.st.*i), two muscular pillars (*m.p.*), each of which, proceeding upwards and outwards, terminates in a chitinous plate, the upper surface of which is, in turn, connected by a fine ligament with the drum (*dr.*). Under a low magnifying power this drum is seen to be strengthened with brownish ribs, which, together with its general elasticity, cause it to spring back after it has been drawn forward by the action of the muscular pillars, the fibres of which are beautifully striated. Each time the drum is drawn forward and springs back, by the alternate contraction and relaxation of the muscular pillars, a sharp click is heard, as may readily be proved experimentally on the dead insect. That the well-known metallic sound is produced by a rapid succession of such clicks is put beyond question by the fact that, by irritating the muscular pillars in a freshly killed insect, the singing noise may be set agoing, and will then continue for several seconds or even minutes. This I had the pleasure of demonstrating to Mr. Roland Trimen, F.R.S., curator of the Cape Town Museum, the abdomen singing merrily when the head and thorax had been pitched out of window or destroyed. A weak current of electricity would also cause the singing to commence. The sound generally ceased after a while in a few isolated clicks, and at that time the waves of contraction in the muscular pillars were plainly visible. The singing noise was less sharp and clear than in the living insect, owing probably to the disruption of some of the resonator membranes; and I have noticed that rhythmical motions of the abdomen in the live insect produce rhythmical alterations in the intensity of the sound. The cover plates are doubtless mainly for protection; but the fact that on their removal the sound is less full and intense shows that they also may play the part of sounding-boards.

Fig. II. is a slightly diagrammatic view of the severed abdomen as seen from the anterior end. *ab.st.*i and ii are the sterna of the first and second abdominal somites; *p.r.m.* the posterior resonator membrane stretched between them; *v.m.* a vertical membrane; *m.p.* the muscular pillars; *dr.* the drum; and *d.c.p.* the dorsal cover plate of the right side, that of the left side being removed.

I may mention, by way of appendix, that in this species the rostrum contains only three stylets: two lateral, toothed on their external edges; one central and smooth. Although this central style shows, in some cases, indications of its having arisen by coalescence of two lateral styles, it is distinctly one and indivisible.

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RADIANT LIGHT AND HEAT[1]

V.

Evidence afforded by the Spectroscope as to the Nature of the Elements

The point of greatest speculative interest connected with our subject is perhaps that regarding the constitution of the so-called elements.

What light, it may be asked, does spectrum analysis throw on this vexed question? Does it lead us to imagine that these bodies are truly elementary? Or to believe that they are in reality compounds which might be broken up if we had sufficiently powerful instruments for this purpose at our disposal?

I shall begin my remarks on this subject by taking it for granted that the constitution of matter is atomic and molecular.

When, therefore, two chemically different substances combine together we have the union of two heterogeneous atoms, forming a molecule of the compound substance. Thus, when an atom of chlorine and one of sodium combine together we have, as a result of the combination, chloride of sodium or common salt, and an ultimate molecule or compound atom of chloride of sodium may be described as the smallest portion of that substance which possesses all the properties of common salt, and which, if divided further, would be split up into one atom of sodium and one of chlorine.

The molecules of bodies are very frequently so placed as to have an attraction for each other, under the influence of which the body assumes a solid, or, it may be, a liquid state.

Sometimes, however, we have the body in the state of gas, in which the various molecules are so far apart as to have no perceptible attraction for each other. It is by means of such a gas that we can best study the properties of molecules as far as radiant light and heat are concerned. Now, spectrum analysis unquestionably tells us that at comparatively low temperatures and great nearness of particles we have a comparatively complicated

[1] Continued from p. 254.

molecular structure. When, however, the temperature is high and the particles far apart, this structure, as revealed by its spectrum, is much simpler. A process of splitting up has taken place in the interval.

While, however, this is universally allowed, there is a difference of opinion as to the nature of this simplification, which, we are assured by the spectroscope, has taken place. Thus we have already seen that in gaseous water or steam we may have, at a somewhat high temperature, a considerable variety of structures and a partial dissociation of the various compound molecules. In such a case we have at the same time portions of the compound and portions of the components, thus exhibiting a more or less complicated structure of the gas. When, however, the temperature gets very high, the dissociation is practically complete, and the compound structures disappear, leaving us with molecules of oxygen and hydrogen. But what will happen if we treat the vapour of iodine in a similar manner? It will be allowed that as the temperature gets higher we shall have a simplification of molecular structure accompanied and exhibited by a great change of spectrum, but will the iodine ever split up into components which bear to iodine a relation similar to that which oxygen and hydrogen bear to water?

In fine, we call iodine a simple body because in the conditions in which we are placed in our laboratories we cannot decompose it; but what is it in the vacuum-tube and under the spectroscope? Is it still an element, or does it give any evidence of being a compound?

It is taken for granted that at high temperatures its molecules split up, but do they split up into portions of iodine or into portions of the components of iodine? In discussing this and similar questions we shall begin by acknowledging that the strongest and best proof of the compound nature of any element is the exhibition of its components in a separate state, while at the same time we must confess that we are at present unable to do this for the so-called elements. Nevertheless this inability forms no ground for the assertion that the elements are simple bodies, inasmuch as certain substances which we know to be compound reveal their components momentarily in the spectral flame. There is a momentary dissociation at a high temperature followed by a reconstruction at a low.

A good instance of this is the yellow flame produced by introducing chloride of sodium into a Bunsen's burner. This yellow flame attests the existence of sodium in the free state, but this existence is merely temporary, and at the end of the process there is no perceptible trace of the presence of this metal. Thus the only difference between the experiment in which the presence of sodium is temporarily revealed and that in which splitting up takes place when the various elementary gases are brought to a high temperature *may be* that in the former instance we can obtain the sodium by another means, whereas in the latter experiments we cannot obtain these constituents by any other means. We say *may be* because we know that our powers are limited and can very well conceive their extension in the future as we know they have extended in the past. We think it, therefore, unphilosophical to assume that there is any real difference between those bodies which we cannot decompose and those bodies which we can, unless there is some good reason for this distinction apart from our inability to decompose the former. Let us now, therefore, inquire whether any such grounds exist.

Our first remark is that in certain respects the elements, with one or two exceptions, may be looked upon as belonging to a distinct family each member of which possesses the same or nearly the same *atomic heat.* This means that the amount of heat necessary to raise through a given temperature range an atom of any one element is equal to that necessary to raise through the same range an atom of any other element.

This fact was first discovered by Dulong and Petit, and is expressed by saying that the product of the specific heat into the atomic weight, or the atomic heat, as this is called, is nearly the same for all the elements.

This peculiar law is not confined to the elements, for it has been found that in all compound bodies of similar atomic composition the product of the specific heat into the atomic weight is likewise constant. This product is, however, greater in the class of compound bodies than it is for the so-called elements. For the latter the product is about 6, while for the chlorides of barium, strontium, calcium, &c., it is over 18, and for the carbonates of lime, barytes, &c., it is nearly 22.

Thus the distinction which the elements enjoy as a family consists in the fact that their atomic heat is less than that of families of compound substances. In order to perceive the physical meaning of this peculiarity let us imagine that we make a mixture of two substances, A and B, which have no sort of chemical attraction for each other. Now in order to heat this mixture through a certain temperature range, the heat required will be the sum of the heats required for the two components, and neither more nor less, the one being in this respect absolutely independent of the other.

Next let us suppose that A and B are both chemical compounds, but that the atomic constituents of a compound atom of A exercise on each other (in order to form the compound atom) attractions vastly greater than those which the compound atoms of A so formed exercise upon each other.

Let us also imagine, that a similar law holds for B, so that in fine we have to deal with the following forces, some of which are strong and others weak. Thus we have:—

(α) The strong forces exercised by the various chemical constituents of a compound atom of A on each other.

(β) The strong forces exercised by the various chemical constituents of a compound atom of B on each other.

(γ) The relatively feeble forces exercised by the various compound atoms of A upon each other.

(δ) The relatively feeble forces exercised by the various compound atoms of B upon each other.

(ϵ) The relatively feeble forces exercised by the compound atoms of A upon the compound atoms of B.

Under these circumstances there are perhaps theoretical grounds for imagining that when we mix A and B together not only shall we have, as above-mentioned, an independence between the specific heats of A and B, but in addition the specific heat of a compound atom of A will be found to be equal, or nearly so, to that of a compound atom of B.

If we now apply these principles to the so-called elementary bodies, we shall, I presume, be all willing to own in the first place, that (assuming for the sake of argument that they are in reality compounds) the force which binds their various constituents together must at any rate be vastly greater than that which represents the attraction of one so-called element for another. Imagine, now, one atom of barium and two of chlorine to combine together to form one compound atom of chloride of barium, we may safely assert that the strength of the chemical ties which bind together the various constituents of this compound atom must be vastly weaker than those which bind together the assumed constituents of the element chlorine or of the element barium. In conformity therefore with the suggestions we have ventured to make we might expect two things to happen:

First, the heat necessary to heat through a given temperature range a compound atom of chloride of barium ought to be nearly equal to the sum of the heats necessary to heat through the same range an atom of barium and two atoms of chlorine.

Next the heat necessary to heat through this range an atom of chlorine ought to be nearly the same as that necessary to heat through the same range an atom of barium, provided both substances are taken in the same state—both solids for instance.

If then the specific heat of an elementary atom is represented by 6, that of a compound atom of chloride of barium will be represented by 18. This is in truth the law which Kopp has found to hold with respect to the atomic heat of compound bodies, and the theoretical conclusion to be derived from it, and that of Dulong and Petit, is, not that the elements are essentially different from the compound bodies, but that, if compound, the forces which bind together their constituents are vastly more powerful than those which bind together the so-called constituents of bodies known to be compound.

Again, if we compare together the atomic weights of the so-called elements with those of compound bodies, we shall find that as a whole the former are smaller than the latter—that is to say, the family of elements have on the whole smaller atoms as well as smaller atomic heats than the families of compounds. Now, if the elements are in reality compounds we might expect in like manner that those which have the smallest atoms should have the smallest atomic heats.

We have great reason for supposing that this is the case, for, although we have not obtained the specific heat of either oxygen or hydrogen in the solid state, Kopp has found that his law with regard to compounds will only hold good under the hypothesis that the atomic heats of hydrogen and oxygen are decidedly less than those of the great bulk of the elementary bodies, that of hydrogen being likewise smaller than that of oxygen. Furthermore carbon and boron are two elements which have small atoms. Now if we make the observation at ordinary temperatures it will be found that the atomic heats of these two elements are decidedly less than those of the great bulk of the elements. In fine, elements of small atomic weight and presumed simplicity of structure appear to bear to those of great atomic weight a relation similar to that which the elements as a class bear to the compounds as a class, as far as atomic heat is concerned.

On the whole the result of this discussion appears to be in favour of the so-called elements being in reality compound structures the components of which possess attractions for each other vastly greater than those exhibited in ordinary chemical combinations.

In connexion with this branch of my subject I may allude to the peculiar family relation between certain elements which all chemists are now agreed in recognising.

This means that the various members of a group of the elements consisting, let us say, of A, B, C, and D, bear to one another some peculiar relation different from that which they bear to the other elements. Now this is precisely what happens in the case of groups of substances which we know to be compound, and the impression is thus conveyed that the elements themselves consist of varied groupings of some still simpler substance. Indeed it seems quite possible that there may be only one kind of primordial atom, and the fact that the force of gravitation bears a constant relation to mass quite independently of chemical constitution seems to speak strongly in favour of some such hypothesis.

Let us now try to picture to ourselves what would have happened had spectrum analysis been known as an instrument of research at the time when we were yet unable to isolate the metal sodium. Under such circumstances chloride of sodium and caustic soda would both be considered as separate elements and the spectra of both these bodies exhibiting the same yellow line would lead to the conclusion that these substances contained some common principle which was momentarily dissociated from its surroundings in the spectral flame. This leads us to ask whether there are any such coincident lines in the spectra of the various so-called elements besides those which may be caused by common impurities. Lockyer, who has greatly studied this subject, tells us that short-line coincidences exist between many metals, the impurities of which have been eliminated, or in which the freedom from mutual impurities has been demonstrated by the absence of the longest lines. Some of his results are exhibited in Fig. 25, in which the lines marked – are due to impurities, while those marked + are common or basic lines. It would thus seem that these short-line coincidences cannot be due to impurities, and the question at once arises whether they do not indicate the presence of some common principle in the spectra before us momentarily dissociated from its surroundings by the high temperature.

It is important here to explain what we really mean when we speak of a coincidence between two spectral lines. We mean simply that there is no perceptible difference in their position when examined with an instrument of a certain power. Mr. Lockyer therefore did not with his instrument perceive any such difference in the spectral position of certain short lines given by various elements. Messrs. Liveing and Dewar, however, applied to some of these lines an instrument of greater power, and succeeded in showing that in many cases there was a slight difference between their spectral positions.

This result raises a new question. We have now to ask ourselves what, under these circumstances, is the value that we can attach to this very near but not quite absolute coincidence between certain short lines of various elements?

Now, in comparing together certain absorptive spectra of compound bodies which have some principle in common, we learn from the researches of Russell and others that we can sometimes trace a band presumably due to the common principle, the spectral position of which is, however, slightly different in the various compounds. The want of perfect freedom may, it is imagined, alter slightly the time of vibration of the molecular groupings, and thus displace the spectral position of the absorption bands. I think we are justified in imagining that something of this kind may take place in the elements, in which, the forces being so intense, our highest attainable temperature may be insufficient to produce complete dissociation. In this case the want of complete concordance in the short lines common to various elements, or *basic lines*, as these have been named by Lockyer, may denote nothing else than this absence of power.

It is imagined that these approximate coincidences are too frequent and too near to be due to chance, but this is a subject that will ultimately require mathematical investigation. In fine, we may conclude this short account of the terrestrial evidence regarding the nature of the elements by saying that—(1) there is no proof that they form a class essentially different from compound bodies, but much to the contrary; and (2) that, if compound, the forces which bind their constituents to one another must be very great.

Before discussing the spectra of the sun and stars it may be well to pause for a moment and ascertain what we mean when we say that sulphur, for instance, is an element. It is quite clear that solid sulphur, liquid sulphur, and gaseous sulphur are different things; also, we may have two kinds of solid sulphur, while if we take the spectrum of gaseous sulphur there is little doubt that the molecular groupings suffer vast changes as the temperature rises.

Now, in all its various states we still call the substance sulphur, because if we bring it down to the temperature of our laboratories it will combine with other bodies as sulphur and as nothing else. Thus the word *sulphur* does not in reality mean a definite arrangement of matter. Similar remarks apply to other elements, several of which are in the form of gas and give us their spectra in vacuum-tubes. Now it is quite possible that in one of these vacuum tubes as we pass the spark through it, we may have various atomic structures, some of which if we could carry them away to a separate place might on cooling present us with something we had never seen before. But this is precisely what we cannot do in the conditions under which we are placed, nevertheless it can be done in the atmospheres of the sun and stars. Prof. Pierce has shown that in such atmospheres where gravity is very powerful, the heavier molecular structures will

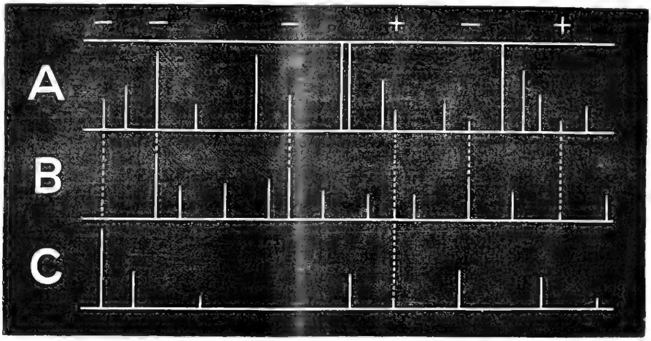

Fig. 25.

naturally separate themselves from the lighter, and seek a lower level. Lockyer therefore imagines that in such atmospheres there is the separation of molecular structures always going on, the heavier falling downwards until they reach a region of higher temperature where they become dissociated or broken up, and the lighter mounting upwards until they reach a region of lower temperature, where they combine together, and hence become

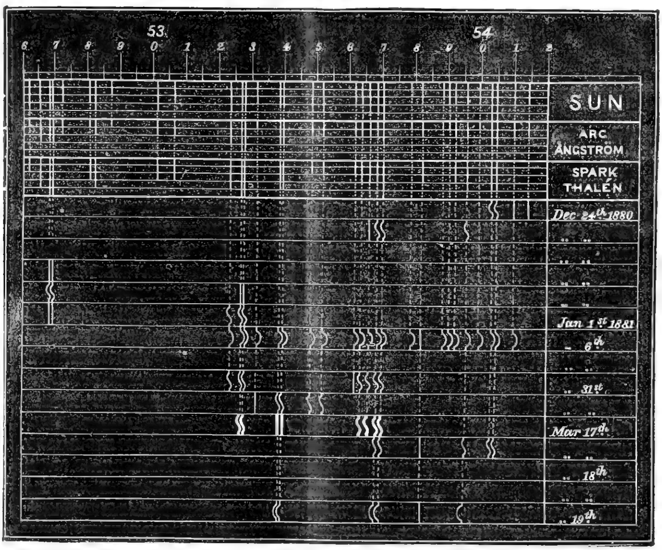

Fig. 26.

heavier. This kind of sifting process must not be confounded with the rapid motions of ascent and descent of the various solar currents, sometimes carrying a body of particles downwards, and thus heating it in the process and sometimes carrying it upwards and cooling it in the process. Both of these causes must be regarded as at work together in the solar atmosphere, and they give us no doubt the best explanation of a very peculiar circumstance which Lockyer was the first to observe. It appears that lines which, judging from terrestrial experiments, belong to one element, sometimes appear in the solar spectrum as distorted or displaced in different directions, indicating perhaps that the substance producing the one line is moving towards the eye with great velocity, while that producing the other is moving in a contrary direction. It is thus certain that the substances producing the two lines must be in different places, and under these circumstances we can hardly come to any other conclusion than that these lines are given out by different molecular groupings which have become separated from each other by the sifting process already mentioned.

From Fig. 26 it will be seen that different rates of solar motion are exhibited by different iron lines.

It would thus appear that a study of the solar spectrum is likely to furnish us with much information regarding the modes of vibration of molecular structures. It would also seem that in view of these facts we should revise our nomenclature. What, for instance, do we mean when we say that iron occurs in the sun? Clearly nothing more than that certain molecular structures in the sun's atmosphere are the same as certain terrestrial molecular structures momentarily formed when we obtain the spectrum of iron. But if we could seize upon the various particles that unite in giving out some one iron line, and put them into a bottle, we might perhaps find that they were not iron, and they might even be different from the thing obtained by treating some other iron line in the same way.

The following statement of Mr. Lockyer's views is taken from the Report of the Solar Physics Committee:—

"The view of the construction of the solar atmosphere to which Mr. Lockyer has been led, may be stated as follows:—If the atmosphere of the sun were quite tranquil, and if we could see the spectrum of a section of it, we should see it divided into an almost innumerable number of layers, each with its appropriate spectrum. So far from each substance (with some notable exceptions), *as determined by a spectral line*, extending very far above or below its normal position, it would be confined to one heat-level, and the spectrum, taken as a whole, would get simpler as we approach the photosphere from without. The metallic elements, instead of existing as such in a so-called 'reversing-layer,' resting on the photosphere, are entirely broken up there, and their germs are distributed throughout the atmosphere, the molecular groupings getting more complex as the distance from the region of greatest heat increases. The Fraunhofer spectrum, as regards any one element, does not result from the vibration of the molecules of that element existing as such at any given height in the sun's atmosphere, but results from an integration of the vibrations of the germs of that element existing, perhaps distributed, from the top of the atmosphere to the bottom."

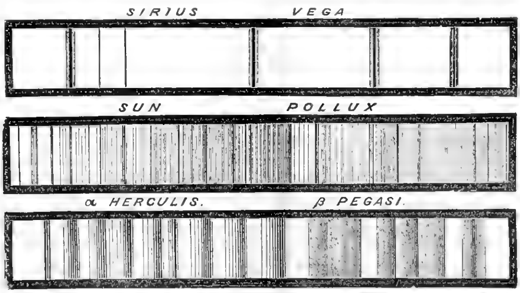

FIG. 27.

It may be said, however, that, while we have strong evidence of a splitting up and also of a sorting or sifting process of the various molecular structures going on in the sun, we are yet without evidence that the molecular structures of two different elements can be split up into the same component. The reply to this will be found in a statement made by Mr. Lockyer (*Proc. R.S.*, December 15, 1881) that the greater part of the lines seen at the bottom of solar spots and in solar flames are lines apparently common to two or more terrestrial substances with the dispersion employed—in other words, basic lines, as these have been termed. He has exhibited some of these results in a diagram which will be found in NATURE, vol. xxiv. p. 323. Now, even if we imagine that the coincidence in position of these lines, as derived from two or more substances, is not absolute, yet the fact that such lines form the greater portion of the spectra belonging to the hotter regions of the sun is a very significant one, and surely implies something more than a mere chance correspondence.

Rutherfurd and Padre Secchi were the first to attempt a preliminary classification of the stars into groups, but for a spectroscopic analysis of these bodies we are especially indebted to Dr. Huggins. Lockyer thus sums up the information which we have thus obtained (December 12, 1878), the symbols indicating the metallic lines visible in the various spectra:—

Hottest Stars	Lines of	H + Ca + Mg
Sun... ...		H + Ca + Mg + Na + Fe
Coolest Stars		— — Mg + Na + Fe + Bi + Hg.
Coolest ...	Fluted bands of	... ... Metalloids.

I may here remark that the hottest stars in the above table are chosen because of their superior brilliancy, and the cooler stars because of their inferior lustre. We are thus entitled to say that the most brilliant and presumably the hottest stars are those in the spectra of which the prominent black lines are the lines of hydrogen, calcium, and magnesium, while in those stars of which the sun is a type we have in addition lines of sodium and of iron. In the cooler stars hydrogen and calcium have disappeared, and we have lines of magnesium, sodium, iron, bismuth, and mercury, while in the coolest stars of all we have no metallic lines but only fluted bands of metalloids. In these last we may imagine that all the metallic lines hav disappeared through association at the comparatively low temperature of the stars.

Fig. 27 gives us a representation of the three chief types of stellar spectra.

It is thus manifest that in stars where the temperature is very high and the dissociation very great we have fewest lines, or at least fewest lines of that prominence and thickness which entitle us to associate them with substances existing below the surface of the stellar atmosphere. Here let us pause for a moment and reflect what this implies. If each element were in reality a simple body, and if the splitting up which occurs in the spectrum of each were merely molecular and not atomic, the result of a high temperature in a mass of matter containing presumably all the elements would certainly not diminish the number of the spectral lines indefinitely. For, even suppose that it split up all the molecular structures of each element into their simplest forms, yet on the supposition that they are elements, the ultimate molecular structure for one element would be different from that for another, and there would thus be at least as many molecular structures and spectral lines as there are elements. On the other hand, if these substances are not elements, we may imagine them to be split up into a comparatively small number of ultimate structures, and we might even imagine that at an enormously high temperature everything might be reduced to a single structure.

Thus the fact that in the hottest stars we have the fewest atomic structures is in favour of the hypothesis that the elements are not really simple bodies but compounds, it may be, of some primordial atom.

Let us now sum up the evidence derived from terrestrial and celestial sources in favour of this hypothesis.

First. There is experimental evidence of various kinds tending to show that the so-called elements are not essentially different from other bodies.

Secondly. In the terrestrial spectrum of pure metals at a high temperature certain lines are obtained for some one element that are extremely near, if not coincident, in spectral position with those obtained for some other element or elements. These have been called "basic lines."

Thirdly. We know that in the sun's atmosphere there is a process at work tending to separate the various molecular and atomic structures, and we find that the greater number of the lines given out from the sun's hotter regions are basic lines, such as we have above defined.

Fourthly. In the very hottest stars, where the dissociation is greatest, we have only a few prominent lines given out, these being lines belonging to hydrogen, calcium, and magnesium. I think we must conclude that the hypothesis that the elements are in reality compound bodies offers, with our present knowledge, a very good and simple explanation of the results of spectroscopic analysis in the earth, the sun, and the stars.

Now, bearing in mind the extreme usefulness of some such hypothesis to aid us in collecting facts, I do not hesitate to say that this hypothesis can only be legitimately overthrown in one of two ways. We may either, in the first place, obtain some indisputable fact bearing conclusively against the hypothesis that the elements are compounds and in favour of their being essentially simple bodies, and may thus overthrow the above hypothesis in the same way that Fizeau, by his experiment, overthrew the corpuscular theory of light, if, indeed, it had not fallen to pieces before he made the experiment; or, on the other hand, the hypothesis that the elements are essentially simple bodies may be applied by some skilled advocate to our terrestrial and celestial spectroscopic observations and a consistent explanation of these afforded, simpler and better than that given by the above-mentioned hypothesis. But until either of these two things is done we are justified in using the compound nature of the elements as a working hypothesis.

It would, no doubt, be premature to bring it forward at the present moment as an established theory, because an established theory means a working hypothesis which, having overcome the perils of infancy and youth, lives to justify an honourable and useful existence on the principle of the survival of the fittest. BALFOUR STEWART

NOTES

THE Paris Academy of Sciences has suffered another loss in the death of M. Jamin, Perpetual Secretary for the Section of Physical Science, and the immediate successor of M. Dumas. M. Jamin can hardly be said to have filled his office, as he was attacked by disease of the heart very soon after his nomination. He was elected a member of the Academy in 1858 to fill the place vacated by the death of Pouillet. He was a very eloquent teacher and debater, and a frequent contributor to the *Revue des deux Mondes*. His "Cours de Physique à l'École Polytechnique," is a very extensive work. He also published many papers in the *Transactions* of the Academy of Sciences, and patented an electric light. He was born in 1813, and educated at l'École Normale.

THE death of Mr. Edward Thomas, one of the most eminent of English numismatists, took place on the 10th inst. at Kensington, in his seventy-third year. After a distinguished career in the public service in India, he returned home and devoted himself to the study of the antiquities and history of India and Asia generally. He was a Corresponding Member of the French Institute and of the St. Petersburg Academy, as well as a Fellow of the Royal Society. His writings were very numerous, and many of them are still only to be found scattered throughout the journals of different learned Societies, to which he had contributed for upwards of forty years. Amongst his most important works were his edition of Prinsep's "Antiquities," published in 1858; papers on ancient Indian minerals in the *Journal Asiatique*; on early Sassanian inscriptions, seals, and coins; his essay on ancient Indian weights prefixed to the "Numismata Orientalia" is the standard work on the subject. Between 1848 and 1866 he contributed sixteen papers to the *Journal* of the Royal Asiatic Society on Eastern coins. These were subsequently republished under the title of "Tracts on Oriental Literature.'

THE death is announced of Dr. Heinrich Fischer, the mineralogist and professor at the Freiburg University, well known through his work on "Jadite and Nephrite."

IN a lively and interesting article in Tuesday's *Times* on the work of the Smithsonian Institution in the field of ethnology it is urged with some force that the British Government is bound to render a similar service to science in the case of the numerous races under our dominion, many of whom are dying out, or changing their old habits and customs. "All the arguments which could be urged for the maintenance of the Smithsonian Bureau of Ethnology apply to the establishment of a similar bureau for the British Empire. In British India the State from time to time undertakes fragments of the task. Elsewhere it is being effected occasionally and piecemeal. The want is of a body which should carry on the enterprise as a whole, and in a manner to borrow light from one quarter to elucidate the rest. Types of tribal, social, and national existence are vanishing on every side. They are changing, or giving place to new. Some had always the germs of incurable decay in them. British civilisation is treading out others. British dominion, whether directly answerable or not for the mortality, is in the position of administrator, and is bound to keep account of the estate of ancient and curious memories. Being where and what it is, it ought to be executing on a scale yet ampler the work the Smithsonian Institution is doing diligently from and at Washington.'

This really forms a part of the much wider question of the duty of the State to science; though with our officials spread everywhere over our world-wide possessions, it ought to be an easy matter to collect abundance of data with which the ethnologist could deal.

M. GRANET, the French Minister of Posts and Telegraphs, is connecting telephonically Paris and Brussels. When the connection has been completed he will also connect Lille and Paris.

IT is satisfactory to learn that success has attended the attempts lately made by the eminent Norwegian naturalist, Herr Bock, and his coadjutor, Herr Schwabe-Hanssen, to introduce a new form of industry into their native land, by utilising some of its numerous beautiful native minerals for the fabrication of various objects of art. For this purpose they have made use of the light-green so-called "precious" serpentine, which, although generally scarce, occurs in abundance at Modum, where ophite and magnetite are also found in sufficient quantities to warrant the hope that the supply will repay the necessary cost of raising and working these decorative minerals. Equally valuable for ornamental purposes are the iridescent, or Labrador, feldspar of Fredriksværn, the avanturine of Tvedestrand, and the tulite of Leksvik, near Trondhjem, but hitherto these minerals have not been found in sufficient quantities to admit of including them among the genuine Norwegian materials of decorative industry.

HERR WERENSKJOLD reports in *Naturen* that on January 5, at 5.20 p.m., he noticed a so-called fire-ball, which was observed in the district of Aas to be moving in a south-westerly direction near Orion's Belt, till it disappeared behind a bank of clouds in the neighbourhood of β Ceti. Its motion was undulatory and slow, and in size and brightness it resembled Venus on an ordinarily clear evening, while it was surrounded by a luminous circle, whose diameter seemed to the observer to be about 2 metres. It continued visible for fully 20 seconds.

IN an interesting paper on the Bushmen and their language, by Mr. Bertin, published in the last number (vol. xviii. part 1) of the *Journal* of the Royal Asiatic Society, the writer discusses the ethnological position of this people. He agrees with Dr. Fritsch in thinking that they have none of the characteristics which would warrant either of the suppositions that they are the result of a mixture of all the runaway slaves, or that they are the broken remnants of a degraded and decayed population. They can only be said to have decayed when they have accepted a certain measure of civilisation. The area formerly covered by them was much larger, and extended over regions now exclusively occupied by Hottentots and Bantu; but there is no means of knowing how far they extended into the interior, although there is some reason to suppose that at one time they occupied the central part of the African continent. Anthropologically, the Bushmen, Mr. Bertin states, offer all the characteristics of the Negritos, especially of those of the Andaman Islands. The similarity is not confined to the skull, as noticed by Prof. Flower, but extends to the colour of the skin, formation and tint of the hair, absence of hair on the body, proportion of the limbs, smallness of the extremities, and reduced size of the stature. The central part of Africa is not yet sufficiently known to enable us to say with certainty whether the Bushmen may be connected with any other African population; but there was, the writer says, a race, now nearly extinct or obliterated, which shows many of the same characteristics, namely, the Egyptian race of the first dynasties. He thinks it safe to say that both populations came from the same primitive stock, and have been modified by crossing with other races, and many other causes. This stock was a kind of Negritoid race; the ancestors of the Bushmen were thrown on the Hottentot population, whether or not this was indigenous or extraneous—in their tales the Bushmen always speak of a previous population inhabiting the country—and it is no doubt the inevitable infusion of Hottentot blood which has given them the few characteristics they have in common.

HERR L. RUTENBERG, of Bremen, the father of the well-known traveller recently murdered in Madagascar, has presented the Bremen Natural History Society with the sum of 2500*l*. for a Rutenberg Fund in commemoration of the services his son rendered to science.

TWO moderately violent shocks of earthquake are reported to have occurred in Rockland County, N.Y., on January 16 about midnight. They were noticed in various localities, such as Haverstraw, Rockland Lake, Spring Valley, Piermont, Sparkill, Nyack, and Suffern; no damage was done.

AN East Greenland Exhibition at Copenhagen, consisting principally of ethnographical objects brought home by the Danish East Greenland Expedition under Lieut. Holm, is attracting much attention in the Danish capital.

THE proprietors of the Ostrau Karwin mines in Silesia have offered, through the Minister of Agriculture, a prize of 1000 ducats to any one who shall discover a method for extracting coal from pits without occasioning accidents by explosions of fire-damp or combustion of coal-dust.

THE will of the late Prof. Henri Milne-Edwards, F.R.S., has been proved in England, the personalty in this country being over 8000*l*.

THE temperature of German Alpine lakes has been recently studied by Herr Geistbeck. It is shown, *inter alia*, that some lakes have a much wider annual variation of temperature than others. Small depth and large affluent streams are causes of a higher temperature in summer and a lower in winter. The cooling in autumn, it is noted, goes on much more rapidly than the heating in spring; for in autumn the upper layers of water, getting heavier through cooling, sink and give place to others, causing a strong and continuous vertical circulation till the whole mass reaches the temperature of greatest density; but in spring this circulation fails. Large affluents, too, by promoting mixture, cause rapid heating. Herr Geistbeck distinguishes three or four zones in these lakes in midsummer. Down to about 6 to 8 metres the fall of temperature is very slight, only a few tenths of a degree. Then, to about 18 metres, there is a rapid fall, from about 14°–20° C. to 8°. The fall continues to about 50 metres, but is now very slow ($3\frac{1}{2}$° to 4°). Below 50 metres the temperature is about constant and 4·2°–4·5°. The daily variation disappears within the highest zone.

FROM a simple experiment with a small ballistic pendulum (*Wied. Ann.* 36), Prof. Mach estimates the velocity of the wave of explosion of 0·02 gr. fulminating silver to be about 1750 metres (say 5833 feet) per second, and so, very much greater than that of ordinary projectiles. Thus is readily explained how a little of the substance exploded electrically on a glass or metal plate, or a card, fixed in a free position, makes a hole through it. The resistance of the air would appear to have nothing to do with it, for explosion *in vacuo* penetrated a card quite similarly, though with less noise. The gases of explosion acquire, in an immeasurably short time, and with nearly the same density as the solid body, the whole high velocity imparted by the work of explosion. As this is of the order of projectile-velocities, the plate is shot through, the lower half of the exploding mass acting against the upper, and the two acquiring equal and opposite velocities. With paper or tinfoil on a table, explosion produced (by reaction, no doubt) an upward convexity, sometimes with rupture.

It is the intention of the authorities at the South Kensington Aquarium to endeavour to introduce herrings into the collection of fish now on view there. The difficulty of naturalising this species to artificial existence is very great, as has been proved by former experiments. At sea-port aquaria, however, where a continuity of salt water may be obtained, this difficulty is obviated to a great extent, but at inland aquaria, where the water is seldom changed, it necessitates extraordinary skill to keep them alive.

At a meeting of the Council of the National Fish Culture Association, held last week, it was stated that the American Government had forwarded another consignment of Salmonidæ ova since the previous week, and the hatchery was now replete with eggs. It was further stated that the hatchery had been reconstructed and enlarged to meet the strain placed upon its accommodative capacity, so that the Association was in a position to incubate any number of ova.

A large supply of salmon and trout ova has been despatched to New Zealand by Sir Francis Dillon Bell, who is most desirous of stocking the waters of that country with Salmonidæ. The ova were obtained by the Tay District Fishery Board, and deposited in the Howietown establishment until ready for shipment. Much is being done to advance the New Zealand fisheries, and the attempts made in this direction have terminated successfully in nearly every instance.

The additions to the Zoological Society's Gardens during the past week include a Pennant's Broadtail (*Platycercus pennanti*) from New South Wales, presented by Mr. H. Stacy Marks, R.A., F.Z.S.; five Adorned Ceratophrys (*Ceratophrys ornata*) from Buenos Ayres, presented by Dr. F. C. Strutt; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Charles Kershaw; a Common Gull (*Larus canus*), a Black-headed Gull (*Larus ridibundus*), a Kittawake (*Rissa tridactyla*), British, purchased.

OUR ASTRONOMICAL COLUMN

Naval Observatory, Washington.—The following novelties occur in the programme of work to be pursued during the year 1886 at the Naval Observatory, Washington, recently published:—

"With the great equatorial it is proposed to make observations of some of the fainter stars in the Pleiades to connect them with the bright ones recently measured with the Yale College heliometer. With the 9·6-inch equatorial observations of variable stars will be commenced. A photometer for this instrument has been ordered from Alvan Clark and Sons; a spectroscope by Hilger is ready for attachment."

The Secular Nutation of the Earth's Axis.—M. Folie, having deduced a periodic formula for the secular variations in obliquity and in longitude, applies the designation secular nutation of the earth's axis to these variations. Defining the *normal* equator as a plane the inclination of which to the ecliptic of a certain epoch is equal to the mean obliquity of that epoch, and the intersection of which with this latter plane passes at each instant through the mean equinox of that instant, he concludes that, in virtue of the secular nutation of the earth's axis, the mean pole describes round the normal pole, considered as fixed, an ellipse the major axis of which, directed towards the pole of the fixed ecliptic (*i.e.* the mean ecliptic of the epoch) is sensibly constant during several centuries. The period of the secular nutation is about 30,000 years, differing little from that of the precession on account of the slow motion of the node of the ecliptic, which is only 8″·7 per annum. Assuming a uniform value of 50″ for the secular diminution of the obliquity, M. Folie compares the results obtained from his formula with ancient observations of the obliquity, and is thus led to announce that the empirical expression $\epsilon_1 = -0''\cdot476 + 0''\cdot000018t$ for the annual diminution (where t is the number of years from 1850) satisfies very closely the observations from − 250 to + 1487. This expression, however, gives a considerably greater variation to the secular diminution of the obliquity than that which results from Leverrier's researches.

Astrophysical Observatory of Potsdam.—The first part of the fourth volume of the publications of this Observatory, which was published in the latter part of last year, contains three papers. The first of these is by Prof. Vogel, and contains the observations which he made with the great Vienna refractor in 1883 for the purpose of testing the performance of the great object-glass. Prof. Vogel's final verdict is altogether favourable: "The Vienna objective," he says, "leaves nothing to be desired as regards the precision of the images;" and he speaks of using with advantage a power even of 1500 upon planetary markings, a statement which is illustrated by a sketch of part of Saturn's ring, as seen with that magnifying power. His principal observations were, however, spectroscopic, Prof. Vogel utilising the great light-gathering power of the Vienna equatorial for a detailed examination of the remarkable spectra shown by several faint stars, classified by him under types II.*b* and III.*b*; the former including spectra showing both dark and bright lines, and the latter, spectra crossed by dark bands, for the most part sharp towards the red and shaded towards the violet. The bright lines in the former class, with the exception of the green line of hydrogen, have not been identified with those of any element. The principal bands of the latter class Prof. Vogel refers, as Dr. Dunér does, to the absorption exercised by hydrocarbons in the atmosphere of the star. The paper also contains a number of observations of nebulæ, principally planetary, and is illustrated by four lithographic plates.

The second paper contains meteorological observations made in the years 1881 to 1883, and the third is a very careful investigation by Dr. G. Müller of the influence of temperature on the refraction of light through prisms, of various kinds of glass, of Iceland-spar and rock-crystal.

Comets Fabry and Barnard.—The brightness of these two comets continues to increase, Fabry's comet in particular promising ere long to be visible to the naked eye; and it seems probable that at the end of April and the beginning of May we may see the unusual spectacle of two bright comets near each other, and very nearly in the zenith.

The following ephemerides are given for Berlin midnight, that for Fabry's comet being by Dr. H. Oppenheim, and that for Barnard's by Dr. A. Krueger:—

Fabry's Comet

1886	R.A. h. m. s.	Decl. ° ′	Log. *r*	Log. Δ	Brightness
Feb. 19	23 21 32	27 13·7 N.	0·0370	0·2058	4·1
23	23 21 0	28 10·6	0·0121	0·1958	4·8
27	23 20 27	29 11·0	9·9860	0·1836	5·7
Mar. 3	23 19 49	30 14·8 N.	9·9591	0·1639	6·9

Barnard's Comet

1886	R.A. h. m. s.	Decl. ° ′	Log. *r*	Log. Δ	Brightness
Feb. 18	2 1 42	18 20·1 N.	0·2017	0·2412	2·9
22	1 59 29	19 20·7	0·1836	0·2426	3·1
26	1 57 39	20 23·4	0·1646	0·2432	3·4
Mar. 2	1 56 8	21 28·4 N.	0·1443	0·2429	3·7

Stellar Photography.—The new nebula around Maia, discovered by means of the photographs taken at the Paris Observatory, has since been seen with the great Pulkova refractor.

M. Cruls, Director of the Rio de Janeiro Observatory, has been commissioned by the Emperor of Brazil to have a photographic apparatus constructed similar to that devised by the Brothers Henry at Paris, in order to co-operate with them in the proposed photographic survey of the sky.

Harvard College Observatory.—Prof. E. C. Pickering has issued his Report for the year 1885. As in former years, chief interest attaches to the photometric researches carried out at the Observatory. With the 15-inch equatorial the photometric observations of the eclipses of Jupiter's satellites have been continued. In all, 319 eclipses have now been observed, 35 since the end of October 1884. The reduction of the photometric observations of the zone stars between the declinations +0° 50′ and +1° 0′ has been carried on, and the observations of DM. stars between + 49° 50′ and + 50° 0′, as well as those between +54° 50′ and +55° 0′, have been completed. These observations have been made with the wedge photometer attached to the large equatorial. The resulting magnitudes have been computed by means of the stars occurring in the zones which are also under observation with the meridian photometer.

The work of the wedge has thus been made homogeneous with that of the meridian photometer. The extensive use thus made of the wedge photometer seems to show that the instrument used at Harvard College is not capable of the great degree of precision which is claimed for that employed by Prof. Pritchard. To determine whether this difference is due to the form of the instrument, Prof. Pritchard has kindly undertaken to superintend the construction of a wedge photometer made upon his plan. The number of series of observations made during the year with the meridian photometer is 202; the number of separate settings somewhat exceeding 50,000. The accordance of the results continues satisfactory; the average deviation of the separate measures of the standard circumpolar stars being 0·12 of a magnitude. The entire series of stars to be observed with this instrument includes zones at intervals of 5° from the equator to the pole; the system adopted insuring a regular distribution of stars down to the ninth magnitude. An important investigation has also been undertaken in stellar photography. A Voigtlander portrait lens of 8 inches aperture and 44 inches focus has been mounted equatorially, and with this many photographs have been taken of the trails left by a star when the telescope is not driven by clockwork, polar stars as faint as the fourteenth magnitude and equatorial stars of the sixth magnitude having been thus photographed. Some most striking results have been obtained with stellar spectra. By placing a large prism in front of the lens, photographs have been obtained of stars as faint as the eighth magnitude, in which lines are shown with sufficient distinctness to be clearly seen in a paper positive. As all the stars in a large region are thus photographed, more than a hundred spectra have been obtained on a single plate.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *FEBRUARY* 21-27

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 21

Sun rises, 7h. 4m.; souths, 12h. 13m. 48·0s.; sets, 17h. 24m.; decl. on meridian, 10° 28′ S.: Sidereal Time at Sunset, 3h. 30m.

Moon (at Last Quarter on Feb. 25) rises, 20h. 2m.*; souths, 2h. 17m.; sets, 8h. 19m.; decl. on meridian, 0° 22′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	7 13	12 7	17 1	13 17 S.
Venus	6 1	11 45	17 29	3 51 S.
Mars	18 48*	1 29	8 10	7 24 N.
Jupiter	20 13*	2 15	8 17	0 22 S.
Saturn	11 49	20 0	4 11*	22 44 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable-Stars

Star	R.A.	Decl.			
	h. m.	° ′			h. m.
U Cephei	0 52·2	81 16 N.	Feb.	21,	21 38 *m*
			,,	26,	21 17 *m*
Algol	3 0·8	40 31 N.	,,	23,	5 47 *m*
			,,	26,	2 35 *m*
λ Tauri	3 54·4	12 10 N.	,,	22,	20 28 *m*
			,,	26,	19 20 *m*
ζ Geminorum	6 57·4	20 44 N.	,,	27,	21 30 *m*
U Monocerotis	7 25·4	9 32 S.	,,	25,	*m*
S Cancri	8 37·4	19 27 N.	,,	26,	1 54 *m*
W Virginis	13 20·2	2 47 S.	,,	25,	5 0 *M*
δ Libræ	14 54·9	8 4 S.	,,	25,	23 2 *m*
U Coronæ	15 13·6	32 4 N.	,,	26,	22 30 *m*
U Ophiuchi	17 10·8	1 20 N.	,,	21,	3 55 *m*
		and at intervals of			20 8
W Sagittarii	17 57·8	29 35 S.	Feb.	24,	2 30 *m*
β Lyræ	18 45·9	33 14 N.	,,	21,	2 30 m_2
			,,	24,	7 0 *M*
R Lyræ	18 51·9	43 48 N.	,,	25,	*M*
δ Cephei	22 24·9	57 50 N.	,,	24,	0 0 *m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Mira Ceti, R.A. 2h 13·6m., Decl. 3° 30′ S., should arrive at maximum about this time, but there seems a little uncertainty as to the precise date. It is possible that it has already passed the maximum. Its spectrum should be examined whilst it remains bright.

Occultations of Stars by the Moon (visible at Greenwich)

Feb.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
21	Uranus	—	5 53	6 34	51 334
23	κ Virginis	4½	1 3	1 20	325 298
25	49 Libræ	5½	2 13	near approach	313 —

Feb.	h.	
21	2	Jupiter in conjunction with and 0° 8′ south of the Moon.
24	16	Mercury in superior conjunction with the Sun.

GEOGRAPHICAL NOTES

LIEUT. WISSMANN, who was on his way back to Europe from his last great journey in the Congo district, stopped at Madeira for the benefit of his health, and has now returned to Africa for further explorations. Lieut. von François, who took part in Lieut. Wissmann's expedition on the Kassai River, has returned to Brussels. He reports that on June 16, 1884, he started with Wissmann from Malange to the Lulua River; thence Wissmann turned northwards and founded the station of Luluaburg, while François investigated the Mukenge district. As he wished to regain Wissmann he built five large boats, in which he reached Luluaburg on the Lulua. He also met Tchingenge, the chief of the Balubas tribe, and Mutenda, one of the first chiefs of the Camokas, who received him kindly. After consulting Wissmann he travelled to the Kassai, which they ascended; then, descending the Congo, they eventually reached Leopoldville, after fifty days' journey. Afterwards François accompanied the missionary, Mr. Grenfell, to the tributaries of the Upper Congo. They first ascended the Lulongo (on the right bank of the Congo), and then the Shuapa, which Stanley names the Uranki. The Shuapa retains its name for the whole length of its course, a circumstance which does not often occur in the Congo lands. It is a large river, navigable everywhere, with extremely fertile banks, which for objects of navigation even surpasses the Kassai. The inhabitants of Batua, on the middle Congo, are a real race of dwarfs. The men have an average height of 1·30 metres, the women of 1·10 metres; but they are well developed and very warlike. When the travellers ascended the river they were attacked by the inhabitants, while on the return journey they were very well received. They also discovered the Bussera, a tributary of the Shuapa. Further on they examined the mouth of the Mobangi, a large tributary of the Congo on its right bank. Grenfell is of opinion that the Mobangi and the Welle River, which has its sources in the Southern Soudan, are one and the same river; François, however, believes that the Mobangi is the continuation of the Nana River, situated further to the north. François states that the land of the Balubas is extremely fertile, no less than three harvests annually being the rule. When exploring the Kassai, François and Grenfell found that this river, instead of joining the Uranki (Shuapa), as Stanley supposed, flows into the Congo near Kwamouth. The Leopold Lake flows into the Kassai at a distance of about 1½° from the Congo. The Lulongo runs parallel to the Congo for a considerable distance on its northern side. The two travellers discovered numerous other smaller tributaries.

A RECENT number of *Cosmos* contains an article by M. de Morgan, who was employed by the Government of the Straits Settlements to prepare a map of the State of Perak in the Malay peninsula, on the Stone Age there. In the course of his work, the writer had to visit the range of mountains forming the watershed of the peninsula, and here came into contact with the Sakayes, Seumangs, Rayats, and other pre-Malay Negrito tribes, as nearly in their original state as they can now be found in these regions. He refers to other tribes living in recesses of the mountains, of whom he learnt from the Sakayes. The latter call them "fire apes"; their language is said to have nothing in common with Malay or Negrito dialects. M. de Morgan received here two polished stone axes, which were said to be made by the "fire apes." One was made of a fine-grained yellow porphyry, and was 224 mm. in length, 53 mm. in breadth, and 16 mm. thick; the other was of a green quartz schist, and was smaller in size. They were polished with great care, and in shape resembled certain Scandinavian stone axes. From inquiries which he made, he came to the conclusion that in recent times there existed in the centre of the Malay peninsula a people wholly ignorant of metals, and he asks whether these "fire apes" are a remnant of the aborigines, who were overwhelmed by a Negrito invasion, or whether they are merely Sakayes who fled before the Malays. The Sakayes, it should be noted, preserve a tradition of the use of stone implements, and it is probable that before the Malay invasion they knew nothing of metals. It is curious to notice that the Malays, who frequently find stone axes in the soil, called them "thunderstones," believing that they proceed from a thunderbolt, thus reproducing an old Breton notion in the centre of the Malay peninsula.

WE have more than once referred to the extraordinary diversity and confusion of the names of States and towns in the eastern half of the Indo-Chinese peninsula. The Marquis d'Hervey de Saint-Denys, well-known for his Chinese researches, has recently read a paper on this subject before the Paris Academy of Inscriptions, which throws much light on the history of this nomenclature. In the sixth century of our era the Chinese, regarding the populations of the present Kuantung, Kwangsi, and Tonquin as barbarians, called them Yuen. When the present Tonquin was conquered and reduced to a Chinese province, they called it Kiao-chi or Kia chow, from the name of the capital, the Hanoi of our days. In 756 they established in Tonquin a great district, which they styled the Annam, or "pacificator of the south." This is the origin of the present designation. In the fifteenth century Annam, then become a feudatory kingdom, was divided into two principalities: the Western Court, Si-tong, and the Eastern Court, Tonquin; hence the latter name. In 1775 the kingdoms of Annam and Cochin China were destroyed by a rebellion, and the last king of the former died at Pekin, whither he had fled. The King of Cochin China, however, succeeded in recovering his throne, and in adding, with the consent of the Chinese, Annam to his dominions. But, in ratifying this union, the Emperor of China bestowed a new name on the whole, Yue-nan. The writer concludes that the country called Annam by the Chinese never went beyond the seventeenth parallel of latitude, and that in every document in which the title occurs the present Tonquin is really meant. It would thus appear that there are, historically, only two countries on the east coast of the peninsula, viz. Annam (which is Tonquin, and nothing more) and Cochin China. But this leaves the present Annam to be accounted for. Possibly nothing short of an International Geographical Congress will succeed in producing a simple uniform nomenclature for this region.

THE *Revue Scientifique* bases the following conclusions on the climate of Tonquin on the evidence given by medical and sanitary experts before the recent Commission of the French Chamber on the subject. Compared with Cochin China, Tonquin is not unhealthy; from September to April there is regular spring, and it is from May to October that the heat is almost insupportable. Except in the mountains, which are dreaded by the natives, and in the forests in the neighbourhood of Hung-hoa, there are no deadly fevers as in Cochin China; especially are there no serious diarrhœas as in the latter. In the delta of the Red River, cultivation and vegetation render it healthy. It is doubtful whether cholera is endemic in Tonquin; the last epidemic appears to have been imported from the Pescadores, and it attacked natives rather than Europeans. But sunstroke is rather prevalent. Two years is the limit assigned for the residence of troops having to undergo great fatigue, with an insufficient quantity of good food; but on occasion this stay may be prolonged without harm to three or four years. Merchants and officials may safely spend fifteen to twenty years in the country.

AT the meeting of the Geographical Society of Paris on January 8, M. Duveyrier described some observations made at Tuggurt in 1860, from which he calculated the latitude at 33° 7′ 0″ and the longitude at 3° 36′ 24″ east of Paris. M. Le Chatelier sent several notes relating to the southern part of Algeria.

THE *Compte rendu*, No. 1, 1886, of the Paris Geographical Society, contains a suggestion from M. Alphonse de Candolle referring to the want in geographical books and works of travel of an analytical index. These works, he says, contain information on natural history, agriculture, mines, ethnography, language, arts, religion, &c., which interest all classes of students, but it is scattered throughout the various works, and few have the patience or the time to get at them by an attentive perusal of the whole. He has often experienced this want himself in preparing his botanical geography, and more recently the work on the origin of cultivated plants. As models of indices he points to Darwin's works, and adds that the more detailed the index is the better. He therefore invites the Society to encourage the addition of indices to geographical works.

THE last *Bulletin* (No. 4, 1885) of the same Society contains the full text of M. Velain's geographical and ethnographical sketch of French Guiana, and the basins of the Yari and Paru, affluents of the Amazon, based on Dr. Crevaux's exploration; of M. de Saint-Pol Lias's account of his journeys in Sumatra and Malacca ("Atché and Pérak"); and of the journeys of MM. Senèze and Noetzli in Ecuador and Peru in 1876-77.

Globus (No. 5, 1886) contains an article by Prof. Blumentritt on the tribe of Guinaus of Abra, in Luzon, based on a communication by Lieut. Trullens, of the Spanish Army, to the *Boletin* of the Philippine Society of the Amigos del Pais. The article describes the houses, mode of life, manners and customs of the tribe. They are confirmed head-hunters, notwithstanding the presence of Spanish troops and police in their territory. Their superstitions, Prof. Blumentritt says, go to strengthen the theory that the religious notions of the Malays all over the Archipelago are broadly the same. It is noteworthy that he laments the general ignorance of ethnology displayed by most Spanish writers on the Philippine races.

THE LUMBAR CURVE IN MAN AND APES[1]

IN this investigation the fresh spines of twelve Europeans, of four anthropoids, of fifteen different species of the lower apes, and several quadrupeds were examined. In each case the body was frozen, and then divided by a saw in the mesial plane. When still in the frozen condition a tracing was taken of the outline of the body, and of the centra of the vertebræ. The results obtained all tend to minimize the importance of the lumbar curve as a distinctive character of any special group. It is present in a well-marked form not only in the chimpanzee, but also in most of the lower apes, and even, under certain conditions, in some quadrupeds (*i.e.* bear). In the chimpanzee the quality of the curve is identical with that of man: it only differs in degree. The latter point could not be absolutely determined, as the four anthropoids examined were little over four years old, and yet the degree of curve was much greater than that of a child of six—indeed it was comparable with that of a child of thirteen.

The second part of the memoir dealt with the adaptation in form of the vertebral bodies to the lumbar curve. By measurements it can be established that in the low races the lumbar curve is not stamped upon the spine so firmly as in the case of the Europeans. In other words, the European lumbar vertebræ are moulded in accordance with the curve, whilst the corresponding vertebræ of the low races are not.

Taking the anterior vertical depth of each vertebral body as 100, the following indices were obtained:—

MAN

		76 Europeans	17 Australians	3 Tasmanians	3 Bushmen	23 Andamans	10 Negroes
Five lower true vertebræ	*a*	106·1	119·8	115·1	115·9	112·6	113·5
	b	101·4	113·	109·9	113·4	111·2	111·3
	c	97·2	113·6	110·1	109·9	108·1	105·9
	d	93·5	103·9	109·5	100·8	102·6	105·1
	e	81·6	90·4	92·4	95·3	91·4	92
Average index		95·8	107·8	107·2	106·6	104·8	105·4

[1] Abstract of a Paper on "The Lumbar Curve in Man and the Apes, with an Account of the Topographical Anatomy of the Chimpanzee." By D. J. Cunningham, M.D. (Univ. Dub.), Professor of Anatomy in Trinity College, Dublin. Read before the Royal Irish Academy, January 26, 1886.

Ape	5 Gorillas	9 Chimpanzees	4 Orangs	6 Gibbons	2 Baboons	3 Macaques	1 Colobus
Five lower true vertebræ *a*	115·3	125·3	113·7	112·8	117·7	109·7	103·8
b	111·7	117·1	118·9	108·8	120·6	107·8	103·8
c	111·3	116·4	119·7	107·5	108	103	103·8
d	105·3	116·1	111·9	106·4	107·3	103·2	108
e	101·9	115·8	103·5	104·1	92·8	96·2	90·4
Average index	108·1	117·5	112·9	107·1	108·5	103·7	102·4

It can be proved in many ways that the lumbar curve of the spine is more marked in the human female than in the male. The methods adopted for the elucidation of this point were: (1) tracings of mesial sections of the frozen spines of the two sexes; (2) Measurements of the anterior and posterior surface of the lumbar region; and (3) measurements of the individual lumbar vertebræ.

The difference between the indices of the vertebræ of the two sexes are not confined to Europeans, but are also observed in four of the five lower races examined, as will be seen from the following table:—

	Irish		Andamans		Negroes	
	21 ♂	23 ♀	14 ♂	9 ♀	7 ♂	3 ♀
Average index of the five lumbar vertebræ ...	96·2	93·5	106·3	102·4	106	103·4

	Australians		Tasmanians	
	10 ♂	4 ♀	2 ♂	1 ♀
Average index of the five lumbar vertebræ ...	110·1	103·1	108·5	104·7

It can be shown that the indices of the lumbar vertebræ of a given European spine are in strict accordance with the degree of lumbar curve. But, whilst this is the case, the difference between the anterior and posterior vertical diameters of the vertebral bodies is so slight (as Weber has observed) that it can have little effect in producing the lumbar curve. The form-adaptation of the vertebral bodies must, therefore, be regarded as the consequence, and not as a cause, of the curve: at the same time it cannot be due to an immediate and mechanical influence operating upon the vertebral bodies during the life of the individual. If it were so, the same characters would be present in the lumbar vertebræ of the low races, and even of the anthropoid. It is an hereditary condition.

The European, who leads a life which rarely necessitates his forsaking the erect attitude except as an intermittent occurrence, and then for short periods, has sacrificed in the lumbar part of the vertebral column *flexibility* for *stability*. It is evident that the deeper the bodies of the vertebræ grow in front, the more permanent, stable, and fixed the lumbar curve will become, and the more restricted will be the power of forward-bending in this region of the spine. The savage, in whose life agility and suppleness of body are of so great an account, who pursues game in a prone position, and climbs trees for fruit, &c., preserves the anthropoid condition of vertebræ, and in consequence possesses a superior flexibility of the lumbar part of the spine.

SNOW-COVERING AND THE WEATHER

DR. WOEIKOF, who is one of the meteorologists of the modern school, has long entertained a deep conviction that meteorology ought not to limit itself to a mere observation of those few instruments which for nearly fifty years have constituted the plant of meteorological Observatories. In the development of its general laws and the application of them to forecasts of weather, it must widen the circle of its observations, and take into account those factors upon which weather and climate depend in each given locality. For the past fifteen years he has devoted his time to the study of local climates and their dependence upon local causes, such as the local deflections of the paths of cyclones and anticyclones; the proximity of seas, steppes, marshes, and forests, and the local heating and cooling of the ground. His chief work, published in Russian, entitled "The Climates of the Globe," is most valuable, on account of the wide knowledge it evinces of the various circumstances on which climate depends, especially with regard to the immense plains of Russia.

The influence of the snow on climate, of its depth and consistency, the time of its first appearance and disappearance, the evaporation from its surface, the purification of air when it has fallen, and a variety of minor circumstances, the importance of which has been insisted on by Dr. Woeikof since 1872, are all referred to. Unhappily, observations on snow are very few and imperfect, and in a paper recently read before the Russian Geographical Society, and now printed in its *Memoirs* (xv. 2), he returns to the subject, illustrating the importance of such observations by a few well-chosen examples.

The year 1877 was a striking instance of how the absence of snow was accompanied by a far less notable lowering of temperature during the prevalence of anticyclones than would have been the case had the soil been covered with snow. In 1877 there was no snow in Eastern Russia until Christmas, and in November and December the anticyclones occurred, accompanied by no wind, or only by feeble breezes. Quite bright weather lasted in December for more than ten days; and still in the region which remained uncovered with snow no great cold was experienced as usually happens in such circumstances: the minima were 8° to 9° above their average values. The same conditions were noticed during the winters of 1879-80 and 1881-82, in West Europe, as shown by Dr. Billwiller in the *Zeitschrift für Meteorologie* for 1882.

In Dr. Woeikof's opinion the relatively high mean temperature of November, as compared with March, in South-East Russia and the Kirghiz Steppe may be explained by the circumstance that in these localities the soil usually is not covered with snow in November; and thus, not being separated from the air by the snow, which is a bad conductor of heat, it rather contributes to maintain a higher temperature in the air resting on it. On the other hand, towards the end of winter the surface is much cooled and exercises a refrigerating influence on the air. Examples from the United States adduced by M. Woeikof seem also to confirm this view.

The refrigerating influence of a thick covering of snow in the spring and the influence it exercises in retarding the arrival of warm weather is so obvious that it need not be insisted on. A paper was written by M. Woeikof, in 1872, on this subject; and the very interesting illustrations he has adduced to show the refrigerating influence of a snow-covering during years when snow was abundant, are very striking. He has since returned to this subject in his "Climates of the Globe," and in the paper we mention; and we may consider it quite established that it is precisely to this agency that the relative coolness of the spring months in Russia and Siberia is due. Moreover, it may be considered as certain that when the snow-covering has been thick, and especially when the snow has a harder consistency, the arrival of warm weather will come on late in the spring.

Another result which Dr. Woeikof has established relates to the commencement of first durable frosts. As long as there is no snow, or little, he argues that frosts may begin, but they will not be durable, and the temperature may rise above the freezing-point; but it is the snow-covering, although not very thick, which gives durability to cold weather. It is easy to foresee how important it becomes, in forecasting the weather, to know, both in spring and autumn, if there are, to the north and east of any region, broad spaces covered with snow.

It is useless to insist upon the importance of an exact knowledge of the depth and consistency of the snow for forecasts in the interests of navigation, especially in countries like Russia, where navigation on so many rivers is carried on only at high water. Several interesting illustrations of this influence are given by the author. In view of these important results, it is most desirable that all observations regarding snow should be made part and parcel of regular meteorological observations. The Ural Society of Naturalists has already collected valuable materials under that head, and it may be assumed that scientific and practical meteorologists will not be slow in taking advantage of such observations. P. K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. S. F. Harmer, B.A., has been appointed Demonstrator of Animal Morphology, in the place of Mr. Walter Heape, resigned. Mr. Harmer was previously Demonstrator of Comparative Anatomy.

The subject for the Sedgwick Prize Essay in 1889 is the Petrology of the Igneous Rocks associated with the Cambrian (Sedgwick) of Carnarvonshire. The essays must be sent in on or before October 1, 1888. It is open only to graduates of Cambridge who have resided sixty days during the year preceding that date.

On the 22nd inst. the General Board of Studies will proceed to nominate a University Lecturer in Geology for five years, in the place of Dr. R. D. Roberts, now Secretary to the London Association for the Extension of University Teaching.

A report of the General Board of Studies has been carried, recommending that no fees shall be paid by students to Professors and Readers in consideration of the lectures which form part of the ordinary duty of their office, but only for further assistance and material or apparatus; also that a return shall be given to the Board of lectures delivered, extra teaching given, and fees charged.

The important proposals respecting the additional subjects in the Previous Examination required of candidates for honours have been carried in such a way as to make them broader in their effects. The substitution of Mechanics for Statics was carried by 58 to 44. The alternative of French or German was introduced by 59 to 42; and then, somewhat surprisingly, the restriction of this alternative to candidates for the Mathematical Tripos, and the requirement that candidates for any other tripos than the Mathematical should pass in the mathematical additional subjects, were rejected by 53 to 49. Thus a great step in advance is made, and any candidate for honours can take Mathematics, French, or German as an additional subject.

Mr. Leslie Stephen has been reappointed an Elector to the Knightbridge Professorship, Lord Rayleigh to that of Chemistry, Mr. Christie, Astronomer-Royal, to the Plumian Professorship; Dr. Humphry has been appointed an Elector to that of Anatomy in place of the late Dr. Allen Thompson; Mr. F. Darwin has been reappointed an Elector to that of Botany; Dr. G. J. Hinde has been appointed an Elector to the Woodwardian Professorship of Geology in place of Rev. E. Hill; Prof. Stokes, P.R.S., has been reappointed an Elector to the Jacksonian Professorship; Dr. H. C. Sorby, F.R.S., to that of Mineralogy; the Right Hon. G. J. Goschen, M.P., has been appointed an Elector of that of Political Economy, in place of Prof. A. Marshall; Prof. H. N. Moseley, F.R.S., has been reappointed an Elector to that of Zoology and Comparative Anatomy; Prof. Stokes, P.R.S., to the Cavendish Professorship; Lord Rayleigh to that of Mechanism; Dr. F. J. Farre to the Downing Professorship of Medicine; Prof. Huxley to that of Physiology; Sir James Paget to that of Pathology; Prof. William Wallace has been appointed an Elector to that of Mental Philosophy and Logic, in place of Mr. James Ward; and Mr. Cadge to that of Surgery. The appointments in each case are for eight years.

The report recommending the institution of a Tripos Examination in Engineering, to be combined to some extent with the Natural Sciences Tripos, has been discussed at some length in the Senate. Mr. Hill thought parts of the Mathematical Tripos and the Special Examination of Engineering sufficient. Mr. Trotter throught the proposed examination was required both for engineering students and students of physics. It was desirable to increase the mathematical training of students of engineering. The Mathematical Tripos had, he thought, suffered from its long and illustrious history. The Examiners felt bound to find something new, and a good deal of students' time was spent in recognising old things in disguised forms, and in solving mathematical puzzles, not suitable for an engineering student pressed for time, or for a student of experimental physics. Prof. Stuart said he was in a position to state that the University had now the opportunity of making its engineering certificate very much ahead of anything else in the world. In one very important respect the new examination would differ from the Mathematical Tripos; it would include practical work in its earliest part.

NEW science buildings are now being erected for Tonbridge School at a cost of nearly 14,000*l*. They will contain chemical and physical laboratories, lecture-room, class-rooms, preparation-rooms, and in addition a library and room for drawing.

SCIENTIFIC SERIALS

The Journal of the Royal Microscopical Society for December 1885 contains:—On some new and rare Desmids, by W. Barwell Turner (plates 15 and 16). Describes a number of new species, for the most part from the United States of America, but the localities are not always very definitely given. A new genus, Leptozosma, is made for a filamentous form near to Bambusina, Kütz, but differing in the sutures. The various forms mentioned are all figured.—Further experiments on feeding insects with the curved or "comma" Bacillus, by Dr. R. L. Maddox. The curved Bacilli are apparently able to retain life in the intestinal tract of flies, and so might possibly become a source of injury to animals.—On the cholera "comma" Bacillus, by G. F. Dowdeswell, M.A.—On an improved form of Stephenson's binocular prisms, by C. D. Ahrens.—Remarks on Prof. Abbe's note on the proper definition of the amplifying power of a lens or lens-system, by Dr. E. Giltay.—On the limits of resolution in the microscope, by Frank Crisp, LL.B., with a note by Prof. Abbe.—The usual summary of current researches and the proceedings of the Society.—At one of the meetings Mr. Crisp exhibited a series of photographic portraits of all the Presidents of the Society. These—eighteen in number—appear in the present part, arranged on two plates of eight portraits each and two full-page portraits of Sir R. Owen, the first President of the Microscopical Society, and of Mr. Glaisher, the first President of the Royal Microscopical Society.

Wiedemann's Annalen, Bd. xxvii. No. 1, January.—F. and W. Kohlrausch, the electro-chemical equivalent of silver, together with an experimental proof of the measurements of intensity of terrestrial magnetism. These determinations, chiefly by the method of Joule, appear to have been made with the utmost regard for precision in all details. The value of the electro-chemical equivalent of silver deduced is about 0·06 per cent. higher than that given by Lord Rayleigh, being 0·0011183 gramme per ampere, as against 0·0011179. Mascart's latest value was 0·0011156. This would make the equivalent of hydrogen 0·000010386.—A. Kundt, on double refraction of light in metal films which are produced by disgregation of a cathode. Films deposited by electric discharges from a pointed cathode show a circularly-arranged dichroism when viewed in the polariscope.—Ch. Lüdeking, on the specific heats, specific gravities, and heats of hydration of the fatty acids and of their mixtures with water.—Otto Schumann, on the density of the adsorbed films of air on surfaces of glass.—J. Lahr, Grassmann's vowel-theory in the light of experiment. Discusses the results obtained by Jenkin and Ewing with a phonograph, and by Schneebeli with a phonautograph.—E. Aulinger, on the relation of Weber's theory of electrodynamics to the principle of unity of electric forces propounded by Hertz.—O. Tumlirz, on the properties of rock crystal in the magnetic field. This paper announces the discovery in this body of residual diamagnetic properties.—Eug. Blasius, notice on Japanese mirrors. Describing kindred phenomena with glass plates which have been scratched at the back with a writing diamond.—E. Lommel, aërostatic balance for the determination of the specific gravities of gases.

Archives Italiennes de Biologie, tome vi. fasc. 3, May 30, 1885.—This part completes volume vi. of this *Archiv*, and in it the editors apologise for its tardy and irregular appearance, which was caused by the terrible epidemic which afflicted Italy in 1884. For the future the *Archiv* will appear not at stated periods, but as matter is ready for publication, every three parts to form a volume. This part contains the last part of a notice of Dr. Beccari's work on "Piante Ospitatrici," by M. E. Levier. These host plants, noticed first by Rumphius in 1750, have been studied in New Guinea and in the Malay Archipelago by Beccari, the first part of whose deeply interesting account of them and their ant guests has but recently been published.—On a case of congenital cataract, by J. Albertotti. The patient was operated on at the age of 21. The operation was a brilliant success, and the experiences noted in this paper are of great value; but the result to the patient may be guessed at by his exclamation some months after the operation: "C'était mieux quand je ne voyais pas."—On the action produced on the sensibility and motility of nerves by dilute hydrochloric acid, by Dr. C. Negro.—Note on pneumonococcus, a grave complication in pneumonia, by P. Foa and G. Rattone.—On the physio-pathological aspects of stratified pavement epithelium, and on the pathogeny of albuminuria, by Prof. G. Tizzoni.—On the presence of albumen in saliva, a criticism of the views of Madame Dessales by Prof. Brancaccio, and a reply by Madame Dessales.—On the central termination of the optic nerve in some mammals, by Dr. J. Bellonci.—On the influence of chloral on gastric digestion, by A. Fiumi and A. Favrat.—Anatomical and clinical study of Morgagni's cataract; and on congenital micro-ophthalmy, by Dr. Falchi.

Rivista Scientifico-Industriale, December 15–31.—Dr. Pietro Cardani, variation of the diameter of the sparks with the potential and the resistance: a study of the way the diameter of the sparks is modified by the resistance of the circuit, and how the diameter itself varies with the increase of the explosive distance. The diameter is found to increase proportionately to the square root of the potential, and to decrease according to a hyperbolical function with the increased resistance; hence for great distances this diameter becomes sensibly constant. The same physicist deals with Harris's second law that the explosive distance varies inversely with the pressure of the gas, and concludes that this law is true only within certain limited conditions.—Dante Roster, remarks in connection with Prof. Mariacher's observations on the food of birds. These studies have a practical value, tending to determine those birds which are insectivorous, and consequently harmless, and those that are graminivorous and injurious to the crops.

Reale Istituto Lombardo, January 7.—Summary of Tito Vignoli's monograph on "The Psychic Act of Attention in the Animal Series," in which the author describes the genesis of attention from the lowest to the highest organisms, analysing the elements of sensation and perception, and determining their comparative values. The physiological and psychological conditions of attention are held to be identical in the higher animals and in man, differing only objectively, and man alone being capable of introspective thought. Hence man is distinguished from other animals, not by the physio-psychic act of attention, but by the faculty of submitting his own intelligence to examination.—In a supplementary note on the transition from animal to human intelligence, Vignoli argues that Darwinism will never succeed in explaining the evolution of the organic from the inorganic, nor of sensation and consciousness from the mere organic. The passage from the intelligence of animals to that of man is not a gradual development of the faculties, but is accomplished by a reflex act of animal intelligence on itself. This act must be instantaneous, consequently is not the result of evolution, as are the physical conditions leading up to it.

SOCIETIES AND ACADEMIES

London

Royal Society, January 7.—"Experimental Researches on the Propagation of Heat by Conduction in Muscle, Liver, Kidney, Bone, and Brain." By J. S. Lombard, M.D., formerly Assistant Professor of Physiology in Harvard University. Communicated by Charles E. Brown-Séquard, M.D., LL.D., F.R.S.

January 14.—"Notes upon the Straining of Ships caused by Rolling." By Prof. Francis Elgar, LL.D., F.R.S.E

It does not appear that any serious attempt has yet been made to investigate the amounts, or even the nature, of the principal straining actions which the rolling of a ship brings into play, or of the effect of those straining actions upon the material of which the hull is composed. Various writers, from Bouguer in 1746, down to Prof. Macquorne Rankine in 1866, and Sir E. J. Reed in 1871, have discussed the straining actions that are caused by longitudinal racking and bending when a vessel is floating in statical equilibrium. Sir E. J. Reed elaborately investigated the subject in a paper contained in the *Philosophical Transactions* of the Royal Society for 1871, and gave examples of the amounts and distribution of the stresses caused by such straining actions in several typical ships of Her Majesty's Navy. Mr. W. John supplemented this by a paper on the strength of iron ships, read before the Institution of Naval Architects in 1874, in which similar results were given for various classes of vessels in the mercantile marine.

The later investigations of these longitudinal straining actions apply not only to the case of a ship floating in equilibrium in still water, but also to cases in which she is (1) in instantaneous statical equilibrium across the crest of a wave; and (2) in instantaneous statical equilibrium across the hollow of a wave—the wave-length being equal to the length of the ship.

Cases frequently occur which show that the maximum stresses of the material of a ship's hull are not in proportion to the results obtained by the ordinary calculations; and that certain deductions that have been drawn from those results are by no means sound. For instance, it is said to follow from the analogy between the longitudinal bending action upon a ship afloat and that upon a loaded girder, that there is little or no stress exerted upon that portion of a ship's plating which is in the vicinity of the neutral axis for the upright position; and the inference has been drawn that, subject to the consideration of the sides being occasionally brought, in some degree, into the positions of flanges of a girder at large inclinations, the thickness of the material may be decreased with advantage near the neutral axis. Now it cannot be shown that the plating which is in the vicinity of the neutral axis when the ship is upright, is ever brought into such a position by the rolling of a vessel as to be much affected by mere longitudinal bending.

Other propositions respecting the distribution of stress in various parts of the structure have been deduced from considerations and assumptions upon which the ordinary calculations of longitudinal strength are based; and rules have, in consequence, been proposed for regulating the strength of the principal component parts of ships' hulls. It is only necessary here to say that many of those deductions, like the one already noticed, are unsound, and are not consistent with the effects that may be observed of straining action at sea.

A considerable experience at sea, where the author has closely observed the effects of straining action caused by twisting moments, and a further experience in investigating the stresses to which the various portions of ships' hulls are subjected according to the theories referred to, and in comparing the results so obtained with the visible evidences of straining action, have convinced him that the stresses caused by twisting moments are much greater than is generally supposed, and that no rules for regulating the strength of ships can be satisfactory if based upon hypotheses that exclude all practical consideration of twisting moments.

The straining action considered in this paper is that caused by the twisting moments which operate when a ship rolls from side to side, and which are caused by differences in the longitudinal distribution of the moments of the forces that cause rotation, and those which resist rotation.

After describing at length the manner in which the twisting moments may be approximately calculated, the author proceeds to consider the amounts and distribution of the stresses upon the material of the hull which are caused by a given twisting moment:—

We can learn something of the nature and distribution of those stresses; but, at present, their amounts cannot be calculated with any reliable approach to accuracy. Experiments are required upon the torsion of thin shells of various prismatic forms in order to furnish the requisite data for dealing with so complicated a case as that of a ship's hull. The difficulty of obtaining exact data is very great; but attention is drawn to some of the general considerations which affect the twisting moments and the distribution of the twisting strains and stresses over a ship's hull; and to the bearing which these have upon the important practical problems that relate to the structural strength of ships.

The best data available for guidance in judging of the distribution of strain and stress due to twisting over the structure of a ship are to be found in M. de Saint-Venant's investigations of the torsion of prisms.[1]

The distribution of the torsional stresses over the transverse section of a ship's hull is obviously different from the distribution

[1] "Mémoires présentés par divers Savants à l'Académie des Sciences de l'Institut Impérial de France," tome 14, 1856. "Mémoire sur la Torsion de Prismes, &c." Par M. de Saint-Venant," pp. 233-560. Also Thomson and Tait's "Natural Philosophy," vol. i., part 2, secs. 699-710.

of the stresses due to longitudinal bending. The parts subjected to greatest stress by twisting are those which are near to the centre of gravity of the transverse section; and they are the side plating near the neutral axis of longitudinal bending in the upright position and the middle portions of the plating of the decks. Those parts of the hull which are usually made the strongest, viz., the strakes of side and bottom plating that are farthest from the neutral axis, and the upper deck stringer plate, are those which are least affected by twisting. It is probably owing, in great measure, to the straining action caused by twisting, that experience has proved it to be necessary to make the outside plating of a ship of nearly uniform thickness over the whole section; and it cannot be because of the reason sometimes given, that the plating in the vicinity of the neutral axis when a ship is upright is often brought by rolling into positions in which it is greatly strained by longitudinal bending.

The importance of many of the structural arrangements of ships which practical experience has shown to be necessary are described in the present paper, and may be understood from the considerations adduced; and it may also be seen that no rules for regulating the strength of ships are likely to be satisfactory if based, as is often done, upon the hypothesis that the straining actions caused by longitudinal bending are so much more important than all others that it is sufficient to regard them alone.

Abstract of Paper on "Proteid Substances in Latex." By J. R. Green, B.Sc., B.A., Demonstrator of Physiology in the University of Cambridge.

The author, after calling attention to the researches of other writers into the nature of the proteids found especially in seeds, described certain bodies found by him to be present in the latex of various plants, chiefly East Indian and South American. The most noteworthy of these was a curious proteid exhibiting relations to the peptones and to the albumoses, resembling the former in being soluble in distilled water, in not being coagulated by heat, and in dialysing through membranes, and agreeing with the latter in being precipitated from its solutions in saturation with solid neutral salts. In addition to this body, which was present in all the samples examined, others were described, including a form of albumen, a globulin, and two albumoses, one of the latter being identical with the hemi-albumose described by Vines as occurring in many seeds. The paper concluded with a recapitulation of the bodies found, and with a detailed summary of their distinguishing reactions.

February 4.—"On Intra-vascular Clotting." By L. C. Wooldridge, M.B., D.Sc. Communicated by Prof. Sanderson.

The author has isolated from the perfectly fresh thymus gland and testis of the calf a substance which, when dissolved in alkaline salt solution and injected into the blood of an animal, causes instantaneous death.

The substance in question is a complex proteid body, and as proof that the effects it produces are due to this proteid and not to any accidental admixture, the author adduces the fact that it becomes entirely inactive after having been subjected for a short time to the action of artificial peptic digestion.

The cause of death is extensive intra-vascular clotting of the blood; if a sufficient quantity be injected, complete thrombosis of the whole vascular system is produced. The substance does not contain any fibrin ferment, nor does the blood which is obtained from an animal after injection of this substance contain more than a minute trace of ferment.

Mathematical Society, February 11.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—Prof. P. H. Schoute, Ph.D., Groningen, Netherlands, was elected a Member.—Capt. P. A. Macmahon, R.A., read a paper on perpetuant reciprocants, the object of which was to present the numerical enumeration of the perpetuant reciprocants of the first six degrees carried out on the plan initiated by Prof. Sylvester (see NATURE, January 7, p. 222, *Comptes rendus*, and the *Messenger of Mathematics*).—The President communicated a note on the functions $Z(u)$, $\theta(u)$, $\pi(u,a)$ by himself, and a note on a $Z(u)$ function by Mr. J. Griffiths.—The Secretary read part of a paper by Mr. R. A. Roberts on polygons circumscribed about a conic and inscribed in a cubic.

Anthropological Institute, January 26.—Anniversary Meeting.—Mr. Francis Galton, F.R.S., President, in the chair.—The following gentlemen were elected Members of the Council for the ensuing year:—President, Francis Galton, F.R.S.; Vice-Presidents: John Beddoe, F.R.S., Capt. R. F. Burton, Prof. G. Busk, F.R.S., John Evans, F.R.S., Prof. Flower, F.R.S., Prof. Huxley, F.R.S., Sir John Lubbock, Bart., F.R.S., Major-General Pitt-Rivers, F.R.S., Edward B. Tylor, F.R.S., Hyde Clarke, Lieut.-Col. H. H. Godwin-Austen, F.R.S., Prof. A. H. Keane; Secretary, F. W. Rudler, F.G.S.; Treasurer, F. G. H. Price, F.S.A.; Council: S. E. B. Bouverie-Pusey, Sir W. Bowman, Bart., E. W. Brabrook, F.S.A., Sir George Campbell, C. H. E. Carmichael, M.A., W. L. Distant, A. W. Franks, F.R.S., J. G. Garson, M.D., A. L. Lewis, Prof. A. Macalister, F.R.S., R. Biddulph Martin, Prof. Meldola, Prof. Moseley, F.R.S., C. Peek, M.A., J. E. Price, F.S.A., Charles H. Read, F.S.A., Charles Roberts, F.R.C.S., Lord Arthur Russell, Prof. G. D. Thane, M. J. Walhouse, F.R.A.S.

Entomological Society, February 3.—Mr. R. McLachlan, F.R.S., President, in the chair.—The President appointed Mr. F. Du Cane Godman, F.R.S., Mr. Stainton, F.R.S., and Mr. J. Jenner Weir, Vice-Presidents for the year.—Dr. Livett, Lieut. Goodrich, Mr. Eustace Bankes, and Mr. F. Enock were elected Fellows, and M. Ragonot of Paris, ex-President of the Entomological Society of France, was elected a Foreign Member.—Mr. C. O. Waterhouse exhibited some cocoons of *Coccidæ* (*Eriopeltis*) found by Mr. Moore on blades of grass at Ilfracombe.—Mr. Douglas sent for exhibition leaves of *Euonymus japonicus*, received from M. Lichtenstein, infested by a coccid, *Chionaspis euonymi*, first noticed in the United States, but which occurred in great numbers at Montpellier and Nismes, and always destroyed the shrubs attacked by it.—The President exhibited specimens of *Tettix australis*, received from Mr. Oliff of the Sydney Museum, who had captured them near Penrith, New South Wales. Mr. Oliff stated that the insects were decidedly sub-aquatic, as he had found them 8 or 10 inches below the surface of the water on the stems of water plants.—Mr. W. F. Kirby exhibited, on behalf of Mr. Ralfe, a series of specimens of *Lycæna corydon* of a very extraordinary character.—The Rev. W. W. Fowler exhibited a specimen of the almost unique beetle, *Harpalus calceatus*, taken by himself at Bridlington; also a specimen of *Apion Lemoroi*, a new French *Apion* taken on the coasts of Normandy and Brittany. He also exhibited several species of British *Helophori*, and read notes on their synonymy.—Mr. H. Goss read an analysis of M. Brongniart's recent work on "Les Insectes fossiles des Terrains Primaires," and expounded that author's views on the classification of insects from geological data.—The Rev. W. W. Fowler read notes on a small collection of *Languriidæ*, with descriptions of two new species.—Dr. Baly communicated a paper containing descriptions of new genera and species of *Galerucidæ*.—Mr. J. Edwards communicated the first part of a synopsis of British *Homoptera* (*Cicadina*).

Institution of Civil Engineers, January 26.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the injurious effect of a blue heat on steel and iron, by Mr. C. E. Stromeyer, Assoc.M.Inst.C.E.

MANCHESTER

Literary and Philosophical Society, December 1, 1885.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—The diffraction of a plane polarised wave of light, by R. F. Gwyther, M.A.—On the different arrangements of equal spherical granules, so that the mean density may be a maximum, by Prof. Osborne Reynolds, F.R.S.

DUBLIN

Royal Society, January 20.—Section of Physical and Experimental Science.—C. R. C. Tichborne, Ph.D., in the chair.—On a nomenclature for facilitating the study of music, by G. J. Stoney, D.Sc., F.R.S.—Notes on improvements in equatorial mountings, by Howard Grubb, M.E., F.R.S. These consisted of a new slow motion in declination, a new position-finder, and a modification of the old differential slow motion in right ascension. Mr. Grubb also described a new slow motion in right ascension, and a new arrangement for electric clock control specially adapted for celestial photography.—Dr. Stoney communicated notes on observations made by Prof. Vogel with the great Vienna refractor.—On a method of determining the specific gravity of a small quantity of a dense solid, also applicable to finding the specific gravity of a small quantity of a porous substance, by J. Joly, B.E. The ordinary method of dealing with minute fragments of minerals, by balancing in a liquid of a specific gravity adjustable to that of the mineral, fails altogether (*a*) when the substance has a specific gravity over 4·5 about; (*b*) when it is of a porous nature. The author deals with minerals having a specific gravity above that of Thulet's solution, or of a porous nature, by embedding a known weight of the mineral in a known weight of paraffin of known specific gravity, and then determining the specific gravity of the mixed bodies by balancing in a solution of low density. From these data the required specific gravity is calculable. Several experiments carried out on fragments of heavy or dendritic minerals ranging in quantity from 12 to 35 milligrames were quoted. These gave results concordant with recorded densities, and, where carried out on pieces removed from the same hand specimen, were uniformly consistent.—Celestial phenomena explicable by meteors, by W. H. S. Monck, M.A.

Section of Natural Science.—J. P. O'Reilly, C.E., in the chair.—Notes on the energy of the Ischia earthquakes of 1881 and 1883, by Rev. Dr. Haughton, F.R.S.—Dr. Haughton also communicated an extract from a letter from a lady in India, respecting the fall of a meteoric stone at Roorkee.—Note on *Edwardsia timida* (Quatr.), by G. T. Dixon, M.A. The specimen was found at Malahide, Co. Dublin. This is the first record of the occurrence of this species in the British Isles.

SYDNEY

Linnean Society of New South Wales, November 25, 1885.—W. J. Stephens, F.G.S., President, in the chair.—The following papers were read:—A list of the Trogositidæ of Australia, with notes and descriptions of new species, by A. Sidney Olliff, F.E.S., Assistant Zoologist, Australian Museum.—Notes from the Australian Museum—a new butterfly of the family Lycænidæ, from the Blue Mountains, by A. Sidney Olliff, F.E.S., Assistant Zoologist, Australian Museum.—On a remarkable fish, from Lord Howe Island, by William Macleay, F.L.S., &c. Under the name of *Ctenodax wilkinsoni*, Mr. Macleay described a fish picked up on the beach at Lord Howe Island, and made some remarks on its probable affinities. He considers it not referable to any known family.—Recent changes in the forest flora of the interior of New South Wales, by R. von Lendenfeld, Ph.D. Based on observations made by Mr. Forest Ranger Ridston and others, and on his own experience in the Nymagee-Condobolin district, the author gives an account of the rapid spreading of the pine (*Frenela robusta*) within the last twenty years. A table giving averages of the rainfall, the spread of the pine and of the beetle *Diodoxus erythrurus*, White, which in its larval stage destroys the young pine-trees, accompanies the paper.—The Australian freshwater Rhizopods, Part I., by R. von Lendenfeld, Ph.D. This paper is the first of an intended series in which the Australian Protozoa belonging to the groups Rhizopoda and Heliozoa are to be registered, and the new species described. In this paper six species are mentioned, two are new. It is a most remarkable fact that the common and well-known European forms are all apparently found in equal abundance in Australian waters. The new species are very similar to European ones, and do not present any marked peculiarities. It does not appear likely that there were no Rhizopods in Australian creeks before the advent of Europeans, and so it cannot be assumed that all these Australian species have been imported. As they cannot travel over the oceans dividing Australia from other continents, it must be assumed that they are unchanged descendants of the Rhizopods of that geological period, in which Australia was not isolated. The absence of forms peculiar to Australia speaks strongly against any recent spontaneous generation.—An Alga forming a pseudomorph of a siliceous sponge, by R. von Lendenfeld, Ph.D.—*Onchidium chameleon*, sp. nov., and the structure of the dorsal skin of this and other Onchidia, by R. von Lendenfeld, Ph.D., and John Brazier, C.M.Z.S.—Observations on some Australian Polychæta, by W. A. Haswell, M.A., B.Sc., &c.—Descriptions of two new fishes from Port Jackson, by E. P. Ramsay, F.R.S.E., &c., and J. Douglas-Ogilby, Australian Museum.—On some remarkable crystals of siderite, by F. Ratte, Eng., Arts and Manufactures (Paris).

PARIS

Academy of Sciences, February 8.—M. Jurien de la Gravière, President, in the chair.—Discourses on the occasion of unveiling the statue erected in front of the Collège de France to the memory of Claude Bernard, on February 4, by MM. Paul Bert, Berthelot, Fremy, and Chauveau. The statue, which is cast in bronze, is the work of M. Guillaume, Member of the Institute.—Farewell address of M. Paul Bert on his departure to Tonquin, where he has recently been appointed Civil Administrator. In the course of his remarks the speaker expressed a hope that the young naturalists of the West would begin to turn their attention to the Far East, and teach the learned classes of those regions more fully to appreciate the superiority of European science. "I rely on them," he added, "to increase our moral influence, and also to enlarge our knowledge of that region, in many places still unexplored, to study its resources, and prepare the way for the introduction of the great European industries. They will thus at once promote the interests of science and of France, a task enviable beyond all others."—Remarks on the celebration of the centenary of Arago's birth on February 26th prox., by M. Mouchez. It was stated by the speaker that the celebration would take the form of a public ceremony in the presence of the various deputations, during which would be crowned the bust of Arago, occupying the site on the Boulevard Arago, where a monumental statue is subsequently to be raised to the great astronomer by public subscription. The proceedings will close with a subscription banquet at the Hôtel de Ville, to which will be invited the members of the Arago family.—Note on celestial photography, by M. Mouchez. Amongst the stellar photographs already obtained at the Paris Observatory, was one of the nebula near the star Maia in the Pleiades, which had never before been seen with the best glasses. But M. Struve now telegraphs to the author that he has just detected this nebula with the new large equatorial of 0·80 m., recently set up in the Pulkova Observatory. It was added that Dom Pedro, Emperor of Brazil, had instructed M. Cruls, Director of the Rio de Janeiro Observatory, to prepare a photographic apparatus similar to that now in use in Paris, for the purpose of co-operating in the general project of photographing the starry regions, already begun with such unexpected success at the Paris Observatory.—Determination of the elements of refraction, two diagrams, by M. Lœwy. It is shown that, in spite of all the rotatory movements of the double mirror, the fundamental condition for determining the constant of refraction is always fulfilled. This principle rests on the geometrical property that the projection of the distance of two images on the trace of the plane of reflection remains invariable and always equal to the distance $r'\rho'$ relative to the epoch when the two stars and their two reflected images are found comprised in the same plane.—On some hyper-elliptical formulas, by M. Brioschi.—Note on the first botanical collections that have reached the Paris Natural History Museum from Tonquin, by M. Ed. Bureau. This first collection, carefully prepared by M. Balansa, is confined exclusively to the neighbourhood of Hai-Phong and of Quang-Yen; but it gives a complete picture of the flora of these districts.—Remarks on the admission of patients suffering from pulmonary tuberculosis into the public hospitals, with a view of determining how far this disease is contagious, by M. E. Leudet. The elements that have served to offer a solution of this question are the records of 16,094 adult patients of both sexes treated in one of the wards of the Rouen Hôtel-Dieu during the thirty-one years from 1854 to 1885. The author concludes that the propagation of pulmonary tuberculosis by contagion in hospitals has not been demonstrated, or that it is at least very restricted.—Observations on Fabry's comet made at the equatorials of the Bordeaux Observatory, by MM. G. Rayet and Courty.—Equatorial observations on Barnard's comet, made at the Bordeaux Observatory, by M. F. Courty.—Observation of Brooks's comet made with the 14-inch equatorial of the Bordeaux Observatory, by MM. G. Rayet and Courty.—On the shower of shooting-stars observed on November 27, 1885, at the Zi-ka-wei Observatory near Shanghai, China, by Père Marc Dechevrens. The meteoric display is described as less imposing than that of November 27, 1872. The stars appear to have swept by at the rate of about a hundred every 15 minutes. Notwithstanding the moonlight a few were still seen so late as 4 a.m. the following morning—On a new system of projection of the sphere suggested by an inquiry into the means of representing the elliptical functions geometrically, by M. Guyon.—Note on Ivory's theorem and on some theorems in connection with the homofocal surfaces of the second order, by M. A. Mannheim.—Researches on the groups of finite order contained in the group of the linear substitutions of contact, by M. Autonne.—Note on a new process for preparing orthophosphoric acid, and the titration of phosphoric and arsenic acids by means of various indicators, by M. A. Joly.—Note on the action of acetic acid on the essence of turpentine, by MM. G. Bouchardat and J. Lafont. It is shown that acetic acid combines already in the cool state with the essence of turpentine, yielding monacetates belonging to two entirely distinct series. At the same time the uncombined essence is transformed into two carburets $C_{20}H_{16}$, one monovalent, analogous to terebinthene, the other bivalent, or active terpilene.—Note on a new direct method of studying animal heat, by M. Desplats. The method here described is carried out by means of M. Berthelot's water calorimeter, but it is applicable only to small animals, such as rats, guinea-pigs, sparrows, &c. At equal weight and in a given time birds are found to evolve three times more heat than mammals, absorbing thrice the quantity of oxygen and emitting three times more carbonic acid.—Note on the Eocene Echinidæ belonging to the family of the Spantangideæ, by M. G. Cotteau.—On some fossil Cycadeæ of the Carboniferous formations, by M. Daubrée.—On a sub-lacustrine moraine on the bar of Yvoise, which divides Lake Geneva into two distinct basins, by M. F. A. Forel. The dredgings carried out in September 1885 have satisfied the author that this bar is, in fact, a glacial moraine like the neighbouring hills. That this moraine, 60 metres below the surface and 1 kilometre from the shore, has been kept clear of recent lacustrine alluvial deposits, is attributed to the action of the sub-lacustrine currents.—Remarks on the geological map of Russian Turkestan prepared by MM. Mushketoff and Romanovsky—six chromolithographic sheets to the scale of 1 : 1,260,000, by M. Venukoff.—Note on the relations existing between the geological, topographic, and chemical properties of the soil and the vegetation covering it in Central Russia, by M. Venukoff.

BERLIN

Meteorological Society, December 1, 1885.—Prof. Börnstein reported on a treatise by Herr van Bebber, which had just appeared, in which the latter, on the ground that typical weather phenomena accompanied the minima that advanced along the well-known highways of storms over Europe, demonstrated that, from the position of the minimum on one of the five highways of storms, and from the local condition of the weather, might be derived the best data as a basis for a trustworthy prognostication of the weather.—Prof. Schwalbe made a comprehensive survey of the investigations that had been carried on by him for several years respecting the ice cavities. In supplement of former reports on these investigations (*vide* NATURE, January 28, p. 312) the following is abstracted from the address which dealt at large with the subject. The earliest notice of the occurrence of ice cavities was contained in an account written in the end of the seventeenth century. In the last and in the beginning of the present century ice cavities had been variously described, but the descriptions were greatly exaggerated. Down even to the present time these enigmas of nature were little known and little investigated. Of all students of natural science whom this subject had engaged, the speaker had assuredly examined the greatest number of ice cavities. Ice cavities formed but one group of ice phenomena, which comprehended likewise dolines, ice holes, rolled ice, ventaroles, and the cold strata of the ground. In the temperate zone they were pretty widely distributed, and occurred in the most varied mountain systems of Europe at heights of from 2000 to 4000 metres above sea-level, and some individual ones at much lower elevations. They were found principally in limestone, in gypsum, in basalt, and lava, but were present likewise in mica slate and other stones. The most essential condition of their presence was that the stone should be readily percolable by water. In the majority of cases the entrance into these cavities was from above, and the passage was directed downwards, yet there were also cases in which the entrance was from below and the passage upwards. The cavities themselves were completely isolated, and no draught of wind was ever perceived in them. The air in the cavities was in winter somewhat colder than in summer, in winter the temperature sinking to 0° C., and somewhat lower, in summer ranging from 4° to 5° C. The walls were always colder than the air in the central part, and the air, moreover, was always completely saturated with moisture. The ice is formed in spring, when the water began to filter through the ground, and almost exclusively on the floor of the cavities. The ceiling was always free of ice, the floor more or less uniformly covered with a thick layer of ice, which, on being broken, splits into prismatic pillars resembling honeycombs. The walls were covered with pearl-like ice-crystals, and stalactitic ice formations came multifariously to view. There was frequent opportunity for observing in an ice cavity how the water-drops, having filtered through the stone, fell to the ground, and there at once congealed. The speaker then referred to and combated the various theories which had been brought forward to explain the ice formation in the cavities. His own view was that the water filtering through the cold stone became refrigerated to excess, and therefore, on falling, at once congealed.

BOOKS AND PAMPHLETS RECEIVED

"Report of the Meteorological Council to the Royal Society for the Year ending March 31, 1885."—"Jubilee Volume of the Statistical Society" (Stanford).—"British Petrography," Part I.: J. J. H. Teall (Watson, Bros., and Douglas, Birmingham).—"Register zu den Bänden 86 bis 90 der Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften" XI. (Gerold's Sohn, Wien).—"Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften; Mathematisch-Naturwissenschaftliche Classe:—Zoologie, Geologie, und Paläontologie," June and July, October to December, 1884, January to April, 1885. Ditto, "Mathematik, Physik, Chemie, Mechanik, Meteorologie, und Astronomie," June and July, October to December, 1884, January to March, 1885. Ditto, Physiologie, Anatomie, und theoretischen Medicin," March to July, October to December, 1884; January and February, 1885 (Gerold's Sohn, Wien).—"Contributions to Canadian Palæontology,' vol. i. part 1: J. F. Whiteaves (Dawson, Bros., Montreal).—"Report of the Meteorological Service of the Dominion of Canada for the Year ending December 31, 1883": C. Carpmael (MacLean and Co., Ottawa).—"Common-Sense Euclid": A. D. Capel (J. Hughes).—"Poultry for Prizes and Profit," parts 4 and 5: J. Long (L. U. Gill)—"British Cage-Birds," parts 5 and 6: R. L. Wallace (L. U. Gill).—"Bees and Bee-keeping," parts 5 and 6: F. R. Cheshire (L. U. Gill).—"Book of the Goat," parts 5 and 6: H. S. H. Pegler (L. U. Gill).—"Fancy Pigeons," parts 5 and 6: J. C. Lyell (L. U. Gill).—"Why we do not adopt the French Metrical System in place of our Anglo-Saxon Metrology": C. Giles (Banks and Son).

CONTENTS

THURSDAY, FEBRUARY 25, 1886

PRESTWICH'S "GEOLOGY"

Geology: Chemical, Physical, and Stratigraphical. By Joseph Prestwich, M.A., F.R.S., F.G.S., Correspondent of the Institute of France, Professor of Geology in the University of Oxford. Vol. I. *Chemical and Physical.* (Oxford: Clarendon Press, 1886.)

THE last few years have been signalised in the annals of geological science by the publication of a number of excellent treatises and students' text-books. Not to mention the appearance of new editions, admirably brought up to date, of such deservedly popular works as Dana's "Manual of Geology," and Credner's "Elemente der Geologie," and of the "Geology for Students and General Readers" of Prof. Green, which is unfortunately still incomplete, we have the revisions of Lyell's "Students' Elements of Geology" by Prof. P. M. Duncan, and of Phillips' "Manual of Geology" by Prof. Seeley and Mr. Etheridge, in which last the additions and alterations are so numerous as to make it practically a new work; among text-books altogether new must be especially noticed the valuable and almost encyclopædic treatises of Dr. Archibald Geikie and Prof. de Lapparent—the necessity for works of this class being shown by the fact that in the course of less than four years they have both reached a second edition. As compared with all these works, however, the new treatise by Prof. Prestwich will be found to cover a somewhat different ground, and indeed to occupy a perfectly unique position among them. It deserves, therefore, to be regarded from another point of view, and to be judged by a somewhat different standard from any of them. Its author is the acknowledged Nestor of British geology, and it may be safely affirmed that no living geologist has contributed in a greater degree to the advance of the science by his important original researches. More than fifty years have elapsed since his first original contribution to geological science was published, and from that date forward his activity has been ceaseless; it is worthy of remark, that while his earliest papers were occupied with the description of some of the oldest formations—the Old Red Sandstone of Banffshire, and the Carboniferous of Coalbrookdale—his later researches have been devoted to the Tertiary and post-Tertiary deposits. But among the writings of Prof. Prestwich will be found some of the most philosophical contributions to geological literature—among which may be especially cited his memoirs on the circulation of underground waters, on the thickness and extension of deep-seated rock-masses, and on the age and relations of the deposits which have yielded the oldest known relics of the human race. A general survey of the wide fields of geological science, by one so especially qualified to undertake the task, may be expected to be of the greatest interest and value; and the expectation is not disappointed by the work now before us.

Upon the death of Prof. Phillips, the University of Oxford, in seeking for a worthy successor to that erudite and versatile geologist, wisely determined to invite Mr. Prestwich to accept the vacant Chair. His able inaugural dissertation on "The Past and Future Work of Geology," which was published in 1875 (see NATURE, vol. xi. pp. 290 and 315), sufficiently informed the world of the position with regard to the different schools of geological philosophy which the new Oxford Professor was prepared to take up. In the present work we find his matured conceptions of the subject, tested in the best possible manner as to their mode of presentation, by having been made the basis of a number of successive courses of University teaching. Every geologist will turn with interest to these pages, and even where they feel compelled to differ from the conclusions arrived at by their author, will render a just homage to the great learning and the judicious thought which are everywhere conspicuous in them.

In the plan of the work, we think Prof. Prestwich has shown the soundest judgment. After a brief introduction treating of the objects and methods of the science, the author proceeds to "give the reader a general sketch of the nature and distribution of the materials with which the geologist has most commonly to deal;" by the avoidance at the outset of difficult and doubtful questions of cosmology, and by reserving those "theoretical questions connected with cosmical and physical phenomena, which relate to the evolution of the globe and historical geology" to the end of the work, he best consults the needs of students—leading them up gradually from a survey of what is simple and known to a consideration of what is complex and unknown.

The two chapters dealing with chemistry, mineralogy, and petrography, large portions of which are printed in small type as being unnecessary for the general reader, would have proved more satisfactory if the author had been more fortunate in the selection of his authorities. Recent researches in those departments of science have been so numerous and of such importance, that few geologists would regard the "Gesternlehre" of Cotta, or the rehabilitation of Cordier's work by Charles D'Orbigny, as affording a sound basis for a summary of the present state of knowledge on these subjects.

But when the author comes to a discussion of the results of the decomposition of the igneous and metamorphic rocks, he is dealing with questions to which he has evidently devoted a large amount of personal study, and his own observations are of the highest value, while his citations from the works of other authors, are in nearly all cases of a very judicious character. The line of argument adopted in the work is necessarily interrupted for a time by the necessity for giving some account of the "place and range of past life," and here, as in the chapters dealing with minerals and rocks, the author has perhaps not consistently followed the best guides. But in the chapters on the formation of sedimentary strata, on the relations of littoral and deep-sea deposits, and on meteorological agencies and the circulation of underground waters, we recognise the hand of a master; and these portions of the work will be found to be worthy of the most careful study. In the very excellent chapter on ice and ice-action, we find many quotations from recent authorities on the subject; and some very interesting illustrations and descriptions are taken from Kane's "Voyages."

In the chapter on volcanoes, the author explains the theory which he first broached at the York meeting of the British Association, and which he has since elaborated in a paper read before the Royal Society. Upon this subject, as well as upon numerous others discussed in the remaining chapters of the volume, geologists will be glad to have brought together the results of the author's extensive study and exceptionally wide experience. While every one will be glad to see the excellent use which has been made of the splendid researches of Delesse and Daubrée, it might perhaps have been better if the author had relied less implicitly upon some others among the older school of French geologists. All will look forward with interest to the appearance of the second and concluding volume of the work, which will treat of stratigraphical geology, and the broader and more theoretical aspects of the science.

The present volume is worthy of the University Press, from which it is issued: well printed upon excellent paper, and illustrated by numerous woodcuts; these have been derived from other standard works, or are founded on sketches by the late Dr. Buckland, while not a few of them bear testimony to the fact that recent publications, like those of the U.S. Geological Survey of the Territories, have been freely placed under contribution; the general appearance of the book is all that could be desired. Among the six excellent folding plates, the first place must be assigned to the beautiful reproduction, on a small scale, of Marcou's geological map of the world, which has been revised by its author for the present work.

We cannot better conclude this notice of a very important contribution to geological literature than by quoting the sentences in which the author himself defines his position towards the different schools of geological thought.

"The fundamental question of *time* and *force* has given rise to two schools, one of which adopts uniformity of action in all time,—while the other considers that the physical forces were more active and energetic in geological periods than at present.

"On the Continent and in America the latter view prevails, but in this country the theory of uniformity has been more generally held and taught. To this theory I have always seen very grave objections; so I felt I should be supplying a want by placing before the student the views of a school which, until of late, has hardly had its exponent in English text-books.

"The eloquence and ability with which uniformitarianism has been advocated, furthered by the palpable objections to the extreme views held by some eminent geologists of the other school, led in England to its very wide acceptance. But it must be borne in mind that uniformitarian doctrines have probably been carried further by his followers than by their distinguished advocate, Sir Charles Lyell, and also that the doctrine of non-uniformity must not be confounded with a blind reliance in catastrophes; nor does it, as might be supposed from the tone of some of its opponents, involve any questions respecting uniformity of law, but only those respecting uniformity of action.

"I myself have long been led to conclude that the phenomena of geology, so far from showing uniformity of action in all time, present an unceasing series of changes dependent upon the circumstances of the time; and that, while the laws of chemistry and physics are unchangeable and as permanent as the material universe itself, the exhibition of the consequences of those laws in their operation on the earth has been, as new conditions and new combinations successively arose in the course of its long geological history, one of constant variation in degree and intensity of action."

Extreme Catastrophists—if indeed any such have escaped extinction during the evolution of modern geological philosophy—will find little in the way of comfort in the above sentences, or indeed in any part of the volume before us. The most pronounced Uniformitarian, on the other hand, will find equally little to take exception to in the general tone of Prof. Prestwich's conclusions; he will perhaps only ask that before recourse is had to non-uniformity in the action of existing causes, the incompetency of the uniform action of those causes to produce any particular phenomena shall be distinctly demonstrated.

THE PICTORIAL ARTS OF JAPAN

The Pictorial Arts of Japan. With 80 Plates and Chromolithographs, and numerous Engravings on Wood and Copper, and with General and Descriptive Text. By W. Anderson, F.R.C.S., late Medical Officer H.M. Legation in Japan. To be complete in 4 parts. Part I. General History. (London: Sampson Low, 1886.)

OF the aboriginal inhabitants of Japan we know but little. A Polynesian element with some Melanesian admixture probably predominated in the southern, as an Aino element did in the northern, islands. Of the latter race the shell-mounds that line the coasts of the main island have afforded many interesting relics, among others fragments of pottery showing a simple ornamentation recalling the zigzags and curves characteristic of the Zuñi and Tesuke pottery of Arizona and New Mexico. It was in the main island, often called Hondo, that the history of Japan began. Not more than two or three centuries probably before the compilation in the eighth century of the Kojiki, the oldest extant document in Japanese literature, a colony of Ural-Altaic origin occupied the broad plain that extends from the northern shores of the Japanese Mediterranean to the foot of the Kiyoto hills. Tradition points to previous settlements of the strangers on the southern islands, whither, pushed by some Central Asian stress from their former home in the Korean peninsula, they had wandered across the narrow waters that separate the Land of Freshness from the Land of Dawn. The new-comers did not easily subdue the Aino tribes, remnants of whom in the north and east still existed, when Yoritomo was created Barbarian-beating Generalissimo in the thirteenth century. More or less amalgamation took place between conquerors and conquered, but the former did not wholly lose their purity of blood, and, to this day, broad physical differences distinguish the peasantry from the more aristocratic strata of the population—differences amply and graphically rendered in the innumerable drawings of Hokusai. These founders of the Japanese State, which, despite the assertions of native writers, can boast of no high antiquity, were a simple folk, living principally on fish and the produce of the chase, clothed in hemp and cloth made of broussonetia bark, and dwelling in wattled huts roofed with bark and reeds. It was not until they were touched by Chinese civilisation that they entered upon the evolutionary course which has ended in a somewhat naïve preference of the civilisation of the West.

There is a difference between symbolism, which all races of men have practised, and art. The reindeer and mammoth drawings of the Cave-men show that a faculty of correct and even spirited drawing was developed at a very early stage in man's history. But the art, like the civilisation, of Europe cannot be traced to the Cave-men; both are a heritage from the Greeks, distributed westwards by Rome. Nor was Greece itself other than an apt soil for the development of seeds brought from Egypt. Who that has gazed upon the wall-paintings of the tomb of Ti at Sakkarah, or has seen the wonderful wooden statue at Boulak, known as the Shêkh-el-Beled, or the sculptures on the sandstones of Wady Mughara, or the figures cut on the obelisk of Heliopolis, can doubt that the men who did these works, full of truth, grace, and vigour, were the worthy foregoers of the sculptors of Greece and the painters of Italy? As the message of Greek art was borne by Rome to the West, so was it carried by the Macedonian conqueror to the northern frontiers of India, where the Buddhists of the Punjab countries pressed it eagerly into the service of their religion. In the sculptures of the monasteries of Yusufzai (Swat frontier of the Punjab) brought to light by Major Cole, R.E., and admirably photographed in the magnificent publication of the Indian Government issued under the title "Preservation of the National Monuments of India," this Græco-Buddhic art is amply exemplified, and most interesting it is to trace in these remains both the reposeful strength which the mobile Greek admired, and the vigorous action which pleased the contemplative Asiatic. Among the most striking of the sculptures are a figure of Maya being borne to the Trayastrinsha heaven, recalling, and probably suggested by, the work of Leochares (B.C. 365) known as "Ganymede carried off by Jupiter's Eagle," the figure of Prince Siddhartha before he left home to become a mendicant, and the wonderful group representing the death of the Buddha, with the face of Devadatta full of evil glee behind the couch. The best Buddhistic works of China or Japan, in comparison with these remains of early Græco-Buddhic art, are merely feeble grotesques, in which the majesty and grace of the prototypes have degenerated into strained pose and gesture and the lifeless prettiness of craftsmanship. The great gateways of the Tope at Sanchi, it may be noted *en passant*, bear a curious resemblance to the *torii* of Shinto shrines in Japan, the principal difference being the presence of a third cross-piece in the former, and the elaborate sculpture of their elements.

In the first century of our era the Buddhist apostles reached China, in the fourth they were in Korea, and in the sixth in Japan. Their art they bore with them, and used as a means of propagation of their doctrines. In the plates numbered 1, 2, 4, 8, 9, 10, and 70—the last a particularly interesting representation by the Chinese artist of the eighth century, Wu-tao-tsu, of the eight Nirvana of Buddha—the characteristics of this missionary art are well displayed, and may be instructively compared with the Yusufzai sculptures.

But even the art of Egypt had its birthplace elsewhere than in the Nile Valley. Recent investigations of the earliest monuments tend to prove, as Mr. Bertin has lately shown, that the Egyptians were not of a Semitic, but of an Equatorial African, stock. Mr. Bertin advances also good grounds for supposing that the Bushmen of South Africa, whose rock-paintings every traveller who has seen them has extolled for their faithfulness and vigour, came of the same or an allied stock. The Bushmen are by no means a degraded, though a stunted, race. They have no kinship with the Negro or even with the Bantu races. Their skulls are well-formed and free from prognathism, and their meagre physique may perhaps be due to the hardship they endured in their secular wanderings over the vast deserts that intervene between the equator and the tracts to the north of the Cape Colony. A psychological connection is thus established between South Africa and the Far East which is worthy of being more fully investigated. There are many facts which tend to add force to this theory, startling though it may appear, which I have no space to dwell upon. I may, however, cite the analogy which seems to exist between the Bushman clicks and the Chinese tones, the former having a similar relation to consonantal to that which the latter possess to vocalic sounds.

Up to the middle of the last century the Chinese school of painting, more or less directly developed from Buddhistic art, held sway in Japan. Its history and the modifications it underwent in the latter country are admirably set forth by Mr. Anderson, and to his account I must refer the reader. About the period referred to a sort of revolt took place in Japan against Sinicism generally. The great Shinto revivalists, Mabuchi, Motöori, and Hirata, scouted Buddhism and Confucianism with equal emphasis. There is a quaintness in their logic which is not unamusing. Motöori, for instance, defends the Shinto lack of a moral code by the answer that the very possession of a moral code was a badge of inferiority, proving as it did the need of it, a need which Japan did not feel, as the people had merely to obey the Mikado, the direct descendant of the Sun Goddess, to be assured of their righteousness. While this religious renaissance was preparing the way for the return of the Mikado to power, a sort of Giottesque revolution took place in art: classicism was, though only partially, abandoned, and a Realistic school (*ukiyoye*) came into existence, of which the master spirit was Hokusai, who died at the age of ninety in 1849. In the *Hiyaku shō den* (the Hundred Heroes) are sketches made by him at the age of eighty-eight. The *ukiyoye* school was that of Japanese art *par excellence*, to a very considerable degree freed from Chinese trammels, and full of the lively and mobile spirit of the people. Mr. Anderson gives a good account of it, but hardly so full as it merits. Nor is it adequately represented in the present instalment, though doubtless it will be so in the complete work. The woodcut, after a drawing by Hokusai, called "The Maniac" (Pl. 37) is a fine example of his fluent drawing and skill and breadth in composition. The last is to me by far the most interesting phase of Japanese art. So it was to Motöori, whose very sensible observations on the subject have recently been translated by that excellent scholar, Mr. Basil Hall Chamberlain (*Tr. As. Soc. Jap.*, vol. xii. p. 223). To Sinico-Japanese art, Motöori, though an enthusiastic patriot, preferred Chinese art, especially the finished pictures of the Chinese, and their rapid drawings of birds, flowers, fish, insects, and the like, and again I share his opinion.

The *ukiyoye* style may indeed justly be regarded as the highest expression of the art of the furthest East. Its limitations are sufficiently obvious and not without interest. The quite childish drawing of quadrupeds is singular. The Japanese artists could draw them well enough when they chose. In one of the volumes of that interminable romance, the "Satomi Hakkenden"—there are more than fifty volumes—there is a splendid sketch of a bull, the wild boar is not seldom vigorously delineated, and Mr. Anderson gives a spirited and fairly correct drawing of a deer (Pl. 31). The explanation probably is that quadrupeds did not interest the Eastern artist, the chase, save of the wild boar, was little in vogue, and rather discouraged by Buddhism. The human face was regarded generally as a mere accessory, and conventionally rendered. There were exceptions: Kikuchi Yosai drew faces vigorously, though even he seemed to limn a profile with difficulty, and the portrait-sculptors of the seventeenth century displayed considerable power. No attempt whatever seems to have been made to portray human beauty of face or form, and the renderings of female beauty are insipid in the extreme, as well seen in the sketch of an ancient hetaira, somewhat truculently called "Hell" Reigan (Pl. 41). The stronger emotions, however, are delineated with a power that would have delighted Darwin, exemplifying admirably his descriptions of the modes of facial expression of the passions of anger, fear, despair, and horror. In some of the novel-illustrations I have seen disdain, reflection, and slyness admirably portrayed. But the softer sentiments are either not depicted at all, or depicted after a purely conventional fashion. The Turanian countenance is not expressive, save of the stronger emotions. A curious mode of portraying anger is to paint streaks of red round the eyes and along the principal lines of expression, nor is the device altogether ineffectual. The Japanese flush with anger, but not with shame; indeed, the feeling of shame they seem to possess but in a minor degree. In some other particulars their modes of expression are peculiar. They nod assent (*unadzuki*), but do not shake their head in dissent. They talk without gestures and with little emphasis of accent, but with curious changes of note and intonation. They never kiss; mothers even do not kiss their children, and they have singularly few terms of endearment. By way of compensation they have few terms of abuse, and no oaths. Their individuality is small, reflected in the curious impersonality of their language (see some excellent remarks on this characteristic by Mr. Aston, *Tr. R. As. Soc.*, vol. xii.); every Japanese is through life a member of a family, or, if a head of a family, a member of some guild or fraternity; he never "paddles his own canoe." Thus may be explained, in great measure, their neglect of humanity in art.

On a future occasion I trust to be allowed to offer a few more remarks on some points in connection with the art of Japan that seem to me interesting in relation to it as a phase in human history. Meanwhile I must not omit a recognition, not the less hearty because necessarily brief, of the value of Mr. Anderson's labours, the extent of which my own studies enable me to appreciate. This is not the place to enlarge upon the artistic merits of his work; they have been, or will be, sufficiently appreciated elsewhere. But the stores of folklore he has gathered together form a contribution to our scientific knowledge of man of extreme importance, and his account of the development of Japanese art is as interesting as it is instructive. The present instalment is admirably got up, and the illustrations, particularly the chromolithographs by Greve of Berlin, are of unsurpassed excellence. Altogether the work promises to be of equal interest and value to the student of man and society, to the lover of art, and to the collector of Oriental curiosities.

F. V. DICKINS

THE EVOLUTION OF THE PHANEROGAMS

L'Évolution des Phanérogames. Par MM. Saporta et Marion. Second Notice. (Paris: Alcan, Boulevard St. Germain, 1885.)

IN our previous notice (vol. xxxii. p. 289) of this important work we traced the evolution of gymnosperms down to a certain point. Prof. Williamson soon afterwards communicated the chief point of difference between his views and those of our authors, in a very interesting letter (NATURE, vol. xxxii. p. 364). We were not able at the time to follow the subject farther, and this was of less consequence, as the points at issue, though extremely important in themselves, are not claimed to be in the direct line of evolution of the existing phanerogams. The palæozoic heterosporous cryptogams, with exogenous stems, are chiefly interesting, from the evolutionary standpoint, for the light they throw on what must probably have been the structure of the common ancestors, from which they, as well as the gymnosperms, were derived. A *résumé* of what is known regarding the ancestry of the Eocene Coniferæ will shortly be published by the Palæontographical Society, the compilation of much of which has been directly assisted by Prof. Williamson himself, and has also been revised in part by Mr. Carruthers. As it is not claimed by Saporta and Marion in any way that angiosperms have been evolutionised from gymnosperms, even through the Gnetaceæ, it is unnecessary to pursue that branch of the subject farther now. The interest of the work centres, in fact, in the attempt to trace the ancestry of the monocotyledons and dicotyledons, groups which to ordinary observers seem to appear with startling abruptness in the geological record.

The differentiation of angiosperms, no less than gymnosperms, originally took place, it would appear, in pre-Carboniferous times, the ancestral forms common to both being heterosporous cryptogams, destitute of exogenous wood. The fundamental difference at starting seems to be that, in the gymnosperms, one of the macrospores contained in the ovule immediately absorbs all the rest, enabling their evolution to proceed with rapidity; while in the angiosperms there is a period of struggle among the macrospores before one finally obtains the advantage and obliterates its fellows. Want of space renders it impossible to give any account of the steps by which the authors have traced out this process. The common source, at a remote period, of the monocotyledons and the dicotyledons, is assumed from the fact that the early stages of the development of the embryo, in some of the former, approach nearer to dicotyledons than to plants of their own class. Moreover, the essential organs, the carpels, stamens, petals, and the fruits, are sufficiently analogous to indicate a common origin. The problem attempted is to reconstruct the "pro-angiospermic" stage whence these two opposite lines have issued. The fully-developed leaves of monocotyledons and dicotyledons embrace many varieties, from the most simple to others that are immensely complicated. Those of the former are generally of the more simple kind, but in the aroïds and Smilax they equal in complexity, and resemble, dicotyledons. It is not among these, however, but, as in zoology, among the embryonic stages, that the ancestral forms are likely to be traced. In many young plants the first leaves are very different in form and structure to those born when maturity is reached. Examples are given of sheathing, amplexicaul phyllodes in *Cicer aristinium*, *Quercus pubescens*, *Asparagus officinalis*, and some *Rosaceæ*, most of which are scale-like and parallel-veined. In *Aralia nymphecæfolia* the stipules embracing the young shoot are of considerable size and adherent for some time. They have a fine parallel venation which scarcely anastomoses and resembles not only the fully-developed leaves of some monocotyledons, but the petals and sepals of many flowers. In *A. Sieboldi* the bracts enveloping the buds and young shoots are similarly constructed, the petiole and true leaf barely emerging from their summit. The sheath, representing the primitive leaf, is in some Umbelliferæ, as the fennel, more important than the secondary leaves, and in one dicotyledon at least, *Eryngium bromeliæfolium*, the latter are not developed at all, the leaves resembling those of a yucca. On the other hand, it is not every monocotyledon that has preserved its primitive leaves only. In *Canna indica*, for example, the inferior and sheathing portion represents the primitive leaf, the middle part, or petiole, the original mucronate apex, and the blade the secondary leaf. Nearer the flower-spike only the primitive leaf-development remains in the form of bracts. The same characters are observed in *Strelitzia regina*. In Aroïdeæ the first leaves are simple and sheathing and the second as complex as those of dicotyledons. *Smilax* furnishes an example of a monocotyledon which has elaborated precisely the same kind of secondary leaf as a dicotyledon. In the grasses the primitive leaf appears on the underground rhizome as a sheath, later reduced to the ligule, while the ribbon-leaf is the homologue of the ordinary dicotyledonous leaf. In palms the primitive leaves are traceable in germination and later in the spathes and bracts, and in an altered condition in the leaf petiole, only the fan part being the secondary leaf.

The ancestral "pro-angiosperms" are supposed to have borne leaves such as are found diminished or masked in so many of their existing descendants—that is, entire, more or less elongated, ribbon-like leaves, amplexicaul at the base, attenuated and mucronate at the apex, and traversed by numerous longitudinal veins, connected by transverse veinlets, or even areolated.

Monocotyledons have, as a class, preserved their primitive foliary appendages more perfectly than dicotyledons, in which they are frequently so reduced as to be barely traceable as lateral expansions of the petiole, or in minute stipules.

The flower is an organ common to both, and must, therefore, have been produced before the two classes had become differentiated. The relative simplicity of structure seen in their several parts is thus explicable—sepals, petals, and bracts being frequently almost reproductions, as to form and venation, of the vagina, or the first sheath leaves, which in many plants succeed the cotyledons, and the terminal mucro can also sometimes be detected. Examples of primitive flowers are seen in *Magnoliaceæ*, *Ranunculaceæ*, and *Nymphaceæ*, but others have doubtlessly been profoundly modified to meet the needs of fertilisation. That the sexual leaves bearing the micro- and macro-sporangia—stamens and pistils—are similarly modified leaves, is also apparent in the case of *Magnolia*. Originally the "pro-angiospermic" flower must have consisted of an axis bearing the sexual appendages spirally disposed one above another, the microsporangial leaves at the base, and the ovule-bearing ones above. Though the flower has became consolidated through the shortening of the axis, its primitive spiral arrangement is traceable in a multitude of angiosperms.

Even the stems in the two classes are not really fundamentally different, the permanent presence or the absence of a productive region of cambium alone sufficing to have originated the two divergent types. In the remote past, before even the seasons were well defined, the cambium layer may have existed in an irregular or fugitive manner in the "pro-angiospermic," as it did in the "pro-gymnospermic" stem, and thence increasing differentiation have produced the two parallel series forming respectively at last dicotyledonous and monocotyledonous stems. Branching probably took place in such primordial stems by means of solitary terminal buds, accompanied perhaps by a restricted number of lateral ones, after the fashion of the screw-pines, aroids, and aloes.

Such was the nature of plants in their "pro-angiospermic" stage. Even the initial difference in the number of cotyledons characterising each class is explicable by supposing them to have been originally of unequal size, and that progressive differentiation led, in the one direction to equalisation, and in the other to suppression. The inequality is preserved in *Nymphaceæ*, which thus serve to diminish the difference in this respect between the two classes. J. STARKIE GARDNER

OUR BOOK SHELF

A Tangled Tale. By Lewis Carroll. With Six Illustrations by Arthur B. Frost. Pp. 152. (London: Macmillan and Co., 1885.)

THE first half of this delightful book consists of ten chapters, or "knots," as they are labelled by the author. Each of these contains a quaint and humorous description of some romantic episode, imagined in order to furnish occasion for proposing certain ingenious mathematical problems to the younger actors in the drama.

The author states that his intention was to embody these questions in each knot "like the medicine so dexterously, but ineffectually, concealed in the jam of our early childhood." This, however, may be noted: in the several doses presented in the volume before us the patient may assimilate all the jam, and, at will, reject the medicine.

The fun and humour with which these sketches sparkle may be enjoyed—and the many sly hits to be found therein may be appreciated—by those who are unwilling or unable to grasp the mathematical question involved.

And for another class of readers there is furnished, in an appendix which fills the latter half of the book, plenty of strong medicine ready to be taken undiluted, if so they choose.

"A Tangled Tale" having originally appeared as a serial in the *Monthly Packet*, many of the fair readers of that magazine, and also some of their brothers, sent up answers month by month to the questions proposed, and these are dealt with in the appendix referred to. A special interest, befitting the occasion, seems to have been taken by several subscribers in the problems so gorgeously dressed up and so prettily put before them. Not only were solutions forthcoming which were correct and neat, but now and then a talented contributor emulates the author himself in regard to the manner and style of wording the answer.

Whilst ample meed of praise is awarded to all good work—and the author's fund of humour never seems to fail him, causing even the initials of his anonymous correspondents to lend themselves to give point to his remarks—where there is any falling away from his high standard of excellence, the criticisms are serious enough, and, if need be, severe.

Fallacies and shortcomings in the answers are laid bare as mercilessly as in the treatise on "Euclid and his Modern Rivals." But great care is taken to bring home to the mind of the hapless contributor a full sense of the error into which he has fallen; and there are several very apt analogies and illustrations to be found in this appendix.

When the sketches first appeared, editors of the puzzle columns of other magazines must have been filled with "mingled feelings of admiration and despair" as they viewed these emanations from Lewis Carroll. And we do not doubt that very many mathematical tutors, as well as their pupils, will read with pleasure and profit "A Tangled Tale," and the appendix thereto, and feel deeply grateful to the author for publishing in book form this further example of his genius.

Mr. Frost has furnished a very striking frontispiece; and of his other illustrations the last may be specially noted here, wherein is depicted a martyr to experimental science who remains steadfast and unmoved at his observations whilst the waves close round and drown him: this is apropos of an exceedingly clever and entirely new "hydrostatic paradox," which the author has invented by dressing up, with the aid of Lardner's "Physics," a very old fallacy.

A. R. WILLIS

Tableaux-Résumés des Observations Météorologiques faites à Bruxelles pendant une période de cinquante années (1833-1882). Préparés par A. Lancaster. I. "Température de l'Air." (Bruxelles, 1886.)

IN this pamphlet of seventy-nine pages Mr. Lancaster admirably resumes the observations of the temperature of the air made at Brussels during the fifty years from 1833, when they were begun by Quetelet, to the end of 1882. An important consideration kept in view throughout is the climatological aspects of the observations, particularly the frequency or rareness of certain temperatures in different times of the year which bear more or less immediately on vegetable and animal life.

From 1833 to 1877 the observations were made with thermometers exposed 10 feet above the ground at a north window of the Observatory; but from the beginning of 1878 the thermometers were placed in a Stevenson screen in the garden at a point 16 feet distant from their original position, and at a height of $4\frac{1}{2}$ feet from the ground. Care was taken at the time of the change to make a double series of observations in the two positions, from which it is shown that the earlier series were $0^{\circ}.8$ too high as compared with the observations made with the Stevenson screen arrangement.

The mean annual temperature of Brussels is $50^{\circ}.5$. The highest annual temperature was $53^{\circ}.8$ in 1834, and the lowest $47^{\circ}.1$ in 1879, there being thus a difference of $6^{\circ}.7$. During the fifty years the greatest difference in the temperature which occurred in the space of any one day was $37^{\circ}.4$ on January 26, 1881. In midsummer the daily maximum occurs at 3.22 p.m., and the minimum at 3.39 a.m.; but in midwinter these phases of the temperature occur at 3.39 p.m. and 6.36 a.m. As regards very high temperatures, $90^{\circ}.0$ or upwards has not been observed earlier than June 6 or later than August 19; and as regards the periods of intensest cold, a temperature of zero Fahr. has been recorded only between January 16 and 26. The longest continued frost was in 1845, when from February 7 to March 22, or during 45 days, the temperature fell to freezing or lower each successive day. The hardest winter was that of 1844-45, when temperature fell to freezing on 90 days, and the most open winter that of 1846-47, when frost was recorded only on 17 days. January 1838 was characterised by severe and long-continued frosts, temperature falling to $23^{\circ}.0$ or lower on 22 consecutive days, to $14^{\circ}.0$ on 13 days, and to $5^{\circ}.0$ on 5 days. The absolutely lowest temperature recorded was $-4^{\circ}.4$ on January 25, 1881, and the highest $95^{\circ}.4$ on July 19 of the same year. The five mean coldest consecutive days of the year are January 8 to 12, the mean being $34^{\circ}.4$; and the five warmest July 15 to 19, the mean being $66^{\circ}.5$. A second maximum occurs from August 13 to 17, when the mean is $65^{\circ}.5$. The most marked interruptions in the annual rise of temperature from January to July are February 10 to 14, April 10 to 14, the middle of May, and June 26 to July 2; and the interruptions in the fall of temperature from July to January are August 13 to 17, already referred to, and December 4 to 7. The interest of these temperature interruptions is their wide geographical range, and no quite satisfactory explanation of them has yet been given.

Notes from the Leyden Museum. Vol. VII. (1885.)

UNDER the able editorship of Dr. F. A. Jentink, the Director of the Leyden Museum, these "Notes" have been published as quarterly parts throughout the past year. They form a volume of some 286 pages, which is illustrated by 10 plates. Among the more important "Notes" we may mention a monograph of the genus Cuscus by the Editor. Four species are recognised: *C. orientalis*, *C. celebensis*, *C. maculatus*, and *C. ursinus*. Gray's species, *C. celebensis*, is re-described, if indeed the original description can be said to merit such a title, being contradictory on most important points, and illustrated with figures of another species. In a note on some rare mammals the same author describes and figures *Hapalemur griseus* and *H. simus*, and notes the occurrence in Central Africa of *Epomophorus comptus* and *E. gambianus*, of *Paradoxurus stigmaticus* and *Ptilocercus lowii* from North-East Sumatra. He also re-describes, almost re-discovers, the rare *Antelope doria*, Ogilby, and *A. longiceps*, Gray. Mr. J. Büttenkofer's "List of Birds collected in Western Liberia" is prefaced by a most interesting account of the Zoological Expedition sent out to the West Coast of Africa under the supervision of the late Prof. Schlegel. Two years and a half (1880-82) were spent in Western Liberia, of which a rough sketch-map is given. The ordinary temperature of Liberia may tolerably well be compared to that of a European summer, rarely ever becoming insupportable. It has its dry and rainy seasons, and produces an extremely rich flora and fauna. His companion, C. F. Sala, died in June 1881, and Mr. Büttenkofer, from ill-health, was obliged to leave for Holland in April 1882. Mr. Stampfli has since gone out, and is now carrying on very successful researches in the southern portions of the district. This paper on the birds of Liberia is to form but one of a series devoted to the different groups collected.

The entomological notes are numerous, and contain descriptions of new or rare Coleoptera by C. Ritsema, J. W. van Lansberge, Neervoort van de Poll, Ant. Grouvelle, Rev. H. S. Gorham, and E. Candèze. Some of the new species are represented on coloured plates. F. M. van der Wulp continues his descriptions of exotic Diptera.

Mr. Schepman describes and figures a new Neritina from Gara, already named in manuscript by E. von Martens as *N. subocellata*, and Dr. Horst gives an account of a new Entozoon from the coeca of *Struthio molybdophanes*, Rchw. This Nematoid (*Sclerostoma struthionis*) is figured on Plate 8.

A title-page and table of contents and index accompany the October part.

Solutions of Weekly Problem Papers. By the Rev. J. J. Milne, M.A. (London: Macmillan and Co., 1885.)

In our notice of the "Weekly Problem Papers" we gave an account of the contents, and accorded to the collection a warm welcome. In the meanwhile we have gone through the major part of the papers, and have found the questions to be well suited for their purpose: here and there may occur occasional apparent exceptions, but if these are exceptions, then were they also in the original papers in which they occur.

The solutions are neat, and in several cases elegant, and in all the object of "increasing a student's stock of mathematical knowledge, and of teaching him to put it to a practical use" is well kept in view. Mr. Milne is prodigal in his solutions, as not unfrequently he gives two solutions of the same question. To compensate for the non-insertion of solutions already printed in the collections of Answers to the Tripos questions of 1875 and 1878, Mr. Milne appends a collection of an equal number of questions of a similar character, with their solutions; these, with two appendices, occupy about one-fifth of the whole volume. The two notes are on the geometrical theory of envelopes and geometrical maxima and minima.

We congratulate Mr. Milne on having so successfully carried out his design. We believe it was originally in his plan to trace each question up to its original proposer, but this very difficult task he has apparently abandoned, at any rate he makes no sign in this first edition.

The two books together will be of great service to students who cannot afford to read with a private tutor, as the solutions are written out in proper style, and are as full in explanation as a student could expect them to be. There is a long list of errata, but of these the greater part are due to the original papers. We have noticed several more, but this is not the place for indicating them, as the student will in most cases be able to detect them himself.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Heat Quantities

It would be a great advantage if some definite and generally-accepted meaning were attached to the words "capacity for heat," "thermal capacity," and "specific heat." As it is I find that scarcely two text-books give the same definitions of these quantities. The French writers, Verdet, Jamin, Fourier (Freeman's translation), and Deschanel (Everett's translation), seem to agree in considering specific heat a quantity of heat; so also do B. Stewart and Daniell. Prof. Everett, in "Units and Physical Constants," defines thermal capacity as a quantity of heat, and on p 79 says that specific heat is also a quantity of heat, while on p. 80 he points out that it is of zero dimensions. In Maxwell's and Garnett's books it is pointed out that specific heat is a ratio, but in the latter the term is used loosely later in the book. Glazebrook and Shaw, in their "Practical Physics," make it a ratio.

To avoid all this confusion, I would propose the following definitions, on the analogy of the accepted ones for density and specific gravity:—

"*Capacity for Heat.*—The quantity of heat required to raise the temperature of any body, under given conditions, by 1° C., is called its 'capacity for heat' under those conditions.

"*Thermal Capacity.*—The quantity of heat required to raise the temperature of unit mass of any material, under given conditions, by 1° C., is called its 'thermal capacity' under those conditions.

"*Specific Heat.*—The ratio of the thermal capacity of any material to the thermal capacity of some standard material is called its 'specific heat.' This standard material is usually water at 0° C. or 4° C."

If some such definitions as these were generally accepted, a good deal of confusion would be avoided, and the analogy with density and specific gravity would be accentuated. At the same time the word "specific" would be defined to mean that the quantity to which it was applied was a ratio, and of zero dimensions. Harry M. Elder

Wellington College, Wokingham

Permanent Polarity of Quartz

The second note in Nature (Feb. 4, p. 325) contains an account of an "important discovery" by Dr. O. Tumlirz, which is wrong in all essential particulars. The permanent polarity discovered by that gentleman is not diamagnetic, but paramagnetic. Nor is it correct that "Dr. Tumlirz appears to think that these facts negative Becquerel's theory of diamagnetism," but on the contrary, he takes some trouble to show that his experiments are in complete agreement with that theory.

"Becquerel's theory (1850)" seems to be a name for the one discussed, though not adopted, by Faraday in his second paper (1845) on the subject, that all matter is magnetic, the medium occupying an intermediate position between so-called paramagnetic and so-called diamagnetic bodies.

Arthur Schuster

[Dr. Tumlirz's own words are: "Der Bergkrystall ist hiermit der erste diamagnetische Körper der eine dauernde Polarität zeigt."—Ed.]

Variegated Iridescent Halo

About noon of January 28 the sky was overcast by a horizontal cloud, and an iridescent halo appeared directly beneath the sun. The length of the arc was not measured, but appeared to be nearly or quite 90°. The most of the halo was of a bright yellow colour, but not far from the middle of the arc was a spot of green separated on each side from the yellow arcs by a short neutral tract. The green spot was nearly round, and its breadth (as measured from the sun) was nearly the same as that of the yellow arcs, and the angular distances from the sun of both the yellow and green arcs were approximately equal. Iridescent halos are seen here every year, usually as complete circles about the sun, and often showing all or several of the prismatic colours, each forming its own definite ring at different distances from the sun. Such halos appear through a thick haze, or quite thin cloud. This variegated halo appeared through a cloud so dense that the position of the sun could barely be made out by the eye, and it was of very variable density. The borders of the coloured arcs were not clearly defined, and apparently the light had been somewhat scattered by reflection upon the lower cloud particles. The temperature was several degrees below the freezing-point of water. Twice before during the present winter short monochromatic arcs of halos have appeared, once a yellowish-green, once a bright red.

The iridescent clouds recently seen by so many of your correspondents in Scotland appear to be, in part at least, the same phenomenon as here recorded, only in this case there was enough of the arc visible to definitely show that the colour was due to an iridescent halo. G. H. Stone

Colorado College

White Rainbows

Probably A. E. E. will find some answer to his questions in the under-mentioned articles:—R. Smethurst, "Account of a White Solar Rainbow" (*Mem.* Phil. Soc., Manchester, iii. pp. 176-78, 1819); Aug. Bravais, "Observations sur le Phénomène de l'Arc-en-Ciel blanc" (*Proc. Verb.* Soc. Philom., pp. 33-35, 1846; *Ann. de Chimie*, xxi. pp. 348-61, 1847); F. Moigno, "Nouvelle Théorie de l'Arc-en-Ciel blanc" Moigno, *Cosmos*, ii. pp. 107-11, 1852-53); G. J. Symons, "On a White Rain- or Fog-Bow" (*Quart. Journ.* Met. Soc., October 1875). A. RAMSAY

A Nocturnal Hymenoptera of the Genus *Bombus*

MR. LEONARDO FEA, Assistant in the Museo Civico of Genoa, who is now engaged in a zoological exploration of Upper Burmah, and who has extensive experience in collecting insects, writes to me from Mandalay that, on the night of January 17, as he was walking in the "compound" of Dr. Barbieri, the moonlight being very bright, he was surprised to hear humming around a clump of flowering acacias. He at once proceeded to fetch a net, and, on capturing the hummers, found, to his no small astonishment, that he had got a fine species of the genus *Bombus*, of a uniform fulvous colour.

Being unaware that the fact of a nocturnal melliphagous Hymenoptera (all of which are eminently diurnal) has been before noticed, I should be glad to hear of any other cases to the point. G. DORIA

Genoa, February 16

PHYLLOXERA AT THE CAPE

WE have received from a correspondent in South Africa some details of the long-dreaded appearance of the Phylloxera in the vineyards of the Cape Colony. As long ago as 1880 the importation of living plants in any form or shape was forbidden by the Cape Government. This measure was so strictly enforced that consignments of young beech-trees from England and of tree-ferns from New Zealand were not allowed to be landed.

In 1884 the prohibition was for a short time relaxed. But it was speedily revived, under a penalty of 500*l.* or two years' imprisonment with or without hard labour in the case of any one infringing it.

The insect has now, notwithstanding, actually appeared in a few vineyards near Cape Town, and in two others about twenty-four miles off.

Fortunately the Cape Government has competent scientific advice at hand. Mr. Roland Trimen, F.R.S., the Director of the South African Museum, and a well-known entomologist, attended the Phylloxera Congress at Bordeaux in 1881 as the representative of the Cape Colony. A Commission to examine and report on the outbreak has been appointed, consisting of Mr. Trimen, of M. Péringuey his assistant, and of Prof. Macowan, F.L.S., Director of the Botanic Garden. M. Péringuey is a Bordeaux man and a good entomologist; he first drew Mr. Trimen's attention to some suspicious-looking mites on a slide which had been taken from a Cape vineyard by the doctor of a French ship, about Christmas.

Two or three of the vineyards are simply swarming with Phylloxera. But in others it appears to have only recent centres. Unfortunately sulpho-carbonates and carbon bisulphide are little more than names in the colony, and it has been necessary to telegraph for a supply. Pending the arrival of the insecticide, the vines are being uprooted and burnt. The result so far is encouraging, and the small range of the insect leads to the hope that it may be well kept under if not stamped out.

OSCAR SCHMIDT

EDWARD OSCAR SCHMIDT was born at Torgau on February 21, 1823. When he had finished his preliminary education he was sent to Berlin, where he had the advantage of studying natural history, to which his mind early had a bent, under the superintendence of Johannes Müller and Ehrenberg. Schmidt, however, proceeded to Jena to take his degree in 1849, and he held the post of Professor of Natural History in the University until 1855. His "Manual of Comparative Anatomy," which went through several editions, was first published in 1849. Appointed Professor of Zoology in the University of Cracow in 1855, he was obliged, two years afterwards, to quit the country, owing to some unfortunate political complications, and he took refuge in Gratz. He was appointed Professor of Zoology and Comparative Anatomy in the University, and in time was made its Rector. During many of his vacation tours he visited the Ionian Islands and other places on the shores of the Adriatic, and, diligently working out the fauna of this almost tideless sea, he became more and more interested in the natural history of the Sponges, with the result that in 1862 he published his well-known and important work, "Die Spongien des Adriatischen Meeres," to which two supplements were issued in 1864 and 1866, followed in 1868 by a third supplement, which formed part of a new work on "Die Spongien der Küste von Algier." It will be conceded that this work of Schmidt's marked an epoch in the history of this interesting sub-kingdom. The enormous progress made in our knowledge of the natural history of the Sponges during the twenty-four years that have elapsed since Schmidt put forward his classification, and the immensely improved methods of research, may be said to have revolutionised the subject; but Schmidt's work will always be of value, and the merit of having grasped the leading features of the classification of the Sponges will generally be awarded to him. That he for the most part failed to perceive the proper specific and generic characters of the forms he describes and figures is not to be much wondered at. In 1870, leaving the Sponge fauna of the Mediterranean, he published his "Grundzuge einer Spongien Fauna des Atlantischen Gebietes," which was followed in 1874 by an account of the Sponges collected by the German Expedition to the North Sea; and his latest contribution to this subject was his work on "Die Spongien des Meerbusen von Mexico, 1879–1880." In 1872 he was appointed Professor of Zoology to the University of Strasburg, returning thus once more to his fatherland.

Though his works on "The Natural Sciences and the Philosophy of the Unconscious" and on "The Descendance Theory of Man and Darwinism" passed through several editions, and were translated into French, they need not be more particularly referred to here. As already noticed in these volumes, Prof. Schmidt died at Strasburg on January 17 last.

THE STORY OF BIELA'S COMET[1]

I ASK you to listen to-night to the story of Biela's comet. I will weave into the story enough of astronomy to justify its place in this course as a lecture.

This story has none of the interest which human passions give to stories of human life, and yet if it shall not be to you as interesting as a novel, it will be because I shall spoil the story in telling it to you. It is a true story. In other words, I mean to separate sharply what we know from what we guess.

One hundred and two years ago last night (March 8, 1772) a Frenchman named Montaigne, in the provincial city of Limoges, found a comet. He did what little he could with his small telescope to mark its place in the heavens, but it was not much that he could do. The comet was a faint one, not to be seen by the naked eye, and had a short tail, only one-eighth as long as across the disk of the moon. He did not dream that that little foggy speck of light was to be one day one of the most interesting comets in the solar system; in fact, that he himself was to be known to history only for having first seen it. This little comet is the hero of my story—a hero from humble life. Montaigne wrote to Paris of his discovery, and they saw it three or four times before it disappeared.

[1] A Lecture delivered by Prof. H. A. Newton, on March 9, 1874, at the Sheffield Scientific School of Yale College, U.S. The renewed interest in Biela's comet created by the great shower of meteors on November 27 last justifies giving space for this lecture. From the *American Journal of Science*.

Thirty-three years later, November 1805, another Frenchman, named Pons, saw the comet. It passed rapidly from the northern heavens, and in a month went below our horizon. It came this time very close to the earth, and I shall in a moment tell you how it appeared. It was visible to the naked eye, even in strong moonlight. Twenty years later, February 1826, an Austrian officer, Von Biela, again found the comet. So soon as an orbit could be computed, it was seen that the three comets of 1772, 1805, and 1826 were the same body. This has since been known as Biela's comet. Its exact path around the sun could now be told. Let me show it to you.

Let us look down upon the solar system from a point several hundreds of millions of miles north of it. Looking southward we should see the sun in the centre. The earth, with its moon, would travel around the sun in a path or orbit denoted by the circle in the figure (Fig. 1).

It goes about the sun once a year, being, on the 10th days of January, April, July, and October, at the points so marked on the diagram. The motion is opposite to that of the hands of a watch. Outside, five times as far from the sun as is the earth, will be the huge planet Jupiter, a part of whose path you see. It goes about the sun once in twelve years. The paths of the other planets are not in the figure, as I have nothing to say about them to-night. In the figures which I show you the earth's orbit is twenty inches in diameter, or one inch to nine million miles. An express railway train travelling all the time for a fortnight would pass over about the thousandth of an inch in this figure. The comet's path is the ellipse. Around this ellipse it travelled three times in twenty years, or once each $6\frac{2}{3}$ years. When nearest to the sun, or at perihelion, it went within the earth's orbit, and when most distant it passed beyond Jupiter.

The comet's motion is very unequal. At D it moves very slowly. As it falls towards the sun the sun's attraction makes it move faster and faster, so that it whisks rapidly by P. As it then rises from the sun on the other side of the orbit, the sun not only turns it ever out of the straight path it would move in, but it stops its upward momentum, so that when it reaches D again it has only its old velocity with which to repeat its circuit. At P its velocity is twenty-eight miles, at D four miles, a second. In fact, to pass over the part lying apparently outside of Jupiter's orbit, just half of the whole $6\frac{2}{3}$ years is required. I said *apparently* outside, for another fact must be noticed: while Jupiter and the earth may be said to move in the same plane, that of the figure, the comet's orbit, lies at an angle. Suppose the ellipse to be a metal ring, and let it turn about the line A B as a hinge, the part A D B rising toward you, and the part A P D retreating from you. The parts near D must rise about the half-diameter of the earth's orbit to give the true position of the two planes. Notice that the comet's and the earth's orbits cut each other

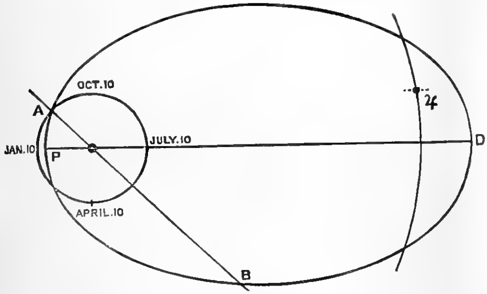

FIG. 1

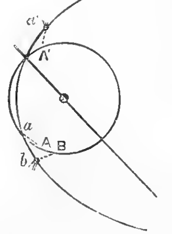

FIG. 2.

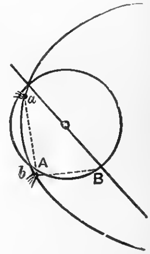

FIG. 3.

at the node on the line A B. The importance of this fact will by and by appear. The two orbits seem to cut each other at another point (below P), it is true, but because of the angle of the planes the cutting is only apparent.

Like all other comets, this one was visible only when near the earth and near the sun. Through the outer part of its path it was never seen, even with a telescope. The comet was seen in 1826 for the third time.

Positions in 1772 *and* 1805.—In March 1772 it was first seen from A in the direction A *a* (Fig. 2). It was last seen four weeks later from B in the direction B *b*. In November 1805 Pons found it when the earth was at A′ and the comet at *a*′ (Fig. 2). Both the earth and the comet were going to the node, the comet going faster than the earth. The earth passed the node just ahead of the comet. I have told you that the comet was then visible to the naked eye even in moonlight, and well it might be. On December 8, with the scale of the figures before you, it was only $\frac{3}{8}$th of an inch from the earth at the node. On the same scale the moon is $\frac{1}{10}$th of an inch from the earth. The comet passed $\frac{1}{18}$th of an inch outside the earth's orbit, but the earth was already past that point.

Dr. Schröter describes the comet: To the naked eye it was (Dec. 8) a large round cloud of light nearly as large as the moon. In a 13-foot telescope it had the same appearance, though it was much smaller, and it had a bright, star-like nucleus. The nucleus had not sharp edges, not even a definitely round form, but was like a light shining through a fog. Its diameter was about 112 miles, or, if we take its central light, 70 miles; speaking roughly, as large as the State of Connecticut. The whole cloud, as seen in the telescope, was some 6000 miles in diameter; to the naked eye perhaps 30,000 miles. How much smaller than 70 miles was the hard part of the nucleus we cannot say.

Position in 1826.—In 1826 it was first seen from A in the line A *a* (Fig. 3). Astronomers followed it with care, as they had come to know that it was a comet of short period, and not many such were then known. Its path then crossed just inside the earth's orbit at the node, but only $\frac{1}{500}$th of an inch in the diagram, or 20,000 miles, in fact, from it.

Position in 1832.—Six and two-thirds years brings us to 1832, and you can readily imagine with what interest this first-predicted return was watched for. Some of you also remember the widespread, though groundless, fears at that time of a collision of the earth and the comet. The comet was first seen by Sir John Herschel in September. In his 20-foot reflecting telescope he saw it pass centrally over a group of small stars of the 16th or 17th magnitude. The slightest bit of fog would have at once blotted out the stars. Through the comet, however, they looked like a nebula, resolvable, or partly resolvable, into stars. How thick the cometic matter was we do not know. Its extent laterally, was not less than 50,000 miles. Again, M. Struve saw it pass centrally over a star of the 9th magnitude. A like star was seen in the telescope at the same time, so that he was able to say that the comet did not dim in the least the one which it covered. The comet, as the figure (Fig. 4) shows, was in 1832 always at a great distance from the earth.

Another $6\frac{2}{3}$ years brings us to 1839. The comet came to perihelion, at P, in July. The earth and comet were on opposite sides of the sun both before and after July, and of course the comet was not seen.

Position in 1845.—Another circuit was finished in 1845-6.

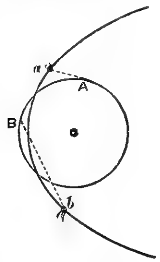

Fig. 4.

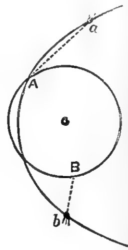

Fig. 5.

The comet was visible then during five months, from *a* to *b* (Fig. 5), or as viewed from the sun through nearly half its circuit. At this time it was that the comet became all at once famous.

On December 29 Mr. Herrick (then Librarian of Yale College) and Mr. Francis Bradley (then in the City Bank) were watching the comet through the Clark telescope in the Athenæum tower yonder. They saw a small companion comet beside the larger one! What did it mean? Had the comet a satellite like the earth's moon? Or had the comet been split by some convulsion? Two weeks later the companion comet was seen by Lieut. Maury and

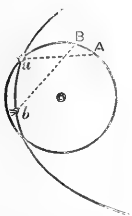

Fig. 6

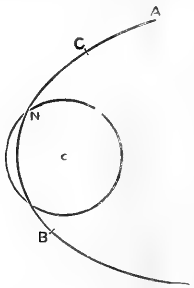

Fig. 7.

Prof. Hubbard at Washington, and two days after that it was seen by two or three European astronomers.

Changes were seen in the larger telescopes that increased the mystery. The faint companion grew in size and brilliancy. Each comet threw out a tail. Then the smaller one had two tails. Then the larger one had a pointed, or diamond-shaped, rather than a round head. Two nuclei were seen in the larger one, and it also had two tails. An arch of light was thrown over from one to the other. For some days in February the companion was the brighter of the two. Presently three tails were seen running from the primary, and three cometary fragments (one observer says five) around its nucleus. What could it all mean? Do you wonder that astronomers were excited by these wizard changes?

The companion comet was seen in Washington by Maury and Hubbard two weeks after it was seen here by Herrick and Bradley. Prof. Joseph Hubbard was the son of a resident of New Haven, well known to many of you from his connection with the New Haven Bank. Prof. Hubbard was graduated two years before (in 1843) at this College, and was now Professor in the Naval Observatory at Washington. He took up the study of the motions of the two Biela comets as special work, outside of his hours on duty. How faithfully he worked, four thick manuscript volumes of figures might tell. I cannot show you those books. They form, since Prof. Hubbard's death, a cherished memento in the possession of a friend. But I have brought another of Hubbard's volumes from the College Library, one of three upon the comet of 1843, in order to show you by what patient labour some of the results of astronomy must be wrought out. In your school days you called it a wondrously long sum that covered both sides of the slate. On the leaves of this book there are, as you see, one, two, three, and in some cases, I think, even four thousand figures upon the page. You will, I am sure, excuse me from telling in detail to-night how we learn about the sizes, distances, and motions of the comets. Eight or ten such volumes of figures, to be increased in time, we hope, by the four Biela volumes, form a monument to a true, devoted, gentle scholar of science. You will not wonder when I tell you that he hated shams.

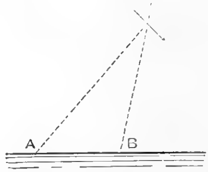

Fig. 8.

Position in 1852.—In 1852 the comet was always at a great distance from the earth (Fig. 6), and only to be seen through the largest telescopes. The changes of size and brightness of the two comets were remarkable, and as they could but just be seen, sometimes one and sometimes the other alone was visible; which one it was that a person saw at any time was only told by computation afterwards.

The two comets were now eight or ten times as far apart as they had been seven years before. They were at the point P, 1,250,000 miles apart. Prof. Hubbard found that he could not tell which comet of 1852 was preceding and which following in 1845. One supposition agreed as well with the observations as the other.

Perhaps the knowing ones among you have noticed that the arc from the node to the point marked Jan. 10 in the first diagram is too large for one month, for in 1772 the earth passed the node Dec. 9. But you will notice that when the comet is at D, and the large planet Jupiter is near by, he draws the comet toward the plane of the figure. The result is to bring the comet down to meet the earth's orbit farther from P. The node thus went back from Dec. 9 to Nov. 27, a distance of 12 days, or 12° in the circle. The figure represents this last orbit. By the same cause the inclination was reduced one-fourth, or from 17° to 12°.

Since September 1852 (with one doubted exception to be spoken of), neither of the two Biela comets had been seen. In 1859 their path was to us behind the sun. In 1866 they should have been at the point P on January 26.

A better chance of seeing them could hardly be. They were at all times to be away from the sun's light, and when nearest to the earth not more than one-fifth the sun's distance. The paths were carefully computed, and the action of all the planets, notably that of Jupiter, allowed for. A dozen observers for months swept the heavens with their telescopes, but not the slightest trace of the comets was seen.

Again, they should have come to perihelion a year ago last autumn (Oct. 6, 1872), but, as I suppose, neither of them was seen. With the loss of its hero, our story would seem to come to an end. I must ask your indulgence, however, for another chapter.

I suppose that each one of you has often seen a shooting-star. On a clear night you have seen a bright point of light travel quickly across the sky, as though a star had been shot from its place in the firmament. It may, if it was a large one, have broken into sparks as it disappeared, or have left a cloudy train along part of its path for an instant; or perhaps it was so faint even that you could not be quite sure that you saw anything. Some of you have seen those shooting-stars by hundreds in star showers.

Until near the close of the last century, poets dreamed, and other men guessed, about these objects, but knew nothing. Two German students, Brandes and Benzenberg, found out, and told us, that these bright flights were in the upper parts of the atmosphere. From the two ends of the city a track always appeared to be in the same part of the heavens. But when one went to a village many miles away, a track was seen by the two persons (at A and B, Fig. 8), in different parts of the sky. Hence they were able to measure the height of the shooting-stars from the ground.

We now know that these luminous paths are rarely less than 40 miles or more than 90 miles from the earth. We also know that any shooting-star was a small body, of unknown size, perhaps not larger than a pebble or a grain of coarse sand even, undoubtedly solid, which has been travelling around the sun in its own independent orbit, like any planet or comet. Its path came within 4000 miles of the earth's centre, and so the small body struck into the earth's atmosphere. Its velocity was so great—fifty or a hundred times that of a cannon-ball—that even in our rare upper atmosphere an intense light and heat was developed by the resistance, and the body was scattered in powder or smoke. These bodies before they come into the air, I call meteoroids. It is only when they have reached our atmosphere and begin to burn that we ever see them. They are then within 90 miles of the ground.

(*To be continued.*)

ON THE COAGULATION OF BLOOD[1]

BRÜCKE'S researches on the conditions of coagulation of blood have shown that, on the one hand, contact with foreign bodies makes blood coagulate, and, on the other, that contact on all sides with the fresh vascular wall obviates coagulation (Durante). Lacker has proved the influence of foreign bodies on blood-coagulation by microscopic observation of coagulation in its first stages. In partial contradiction to these results was the observation of Grünhagen that blood, when received into glycerine, and so long as it did not mix, remained liquid. To determine the nature of these influences the following experiments were made. Blood was drawn under oil from the carotid artery of a dog, and let stand at ordinary indoor-temperature; after twenty-four hours it was *not* coagulated. Then the blood was drawn into a vessel smeared inside with vaseline, and it too *did not coagulate.* When it was stirred with an oiled glass rod, no fibrin was separated; but when, even after several hours, part of this blood was poured into an ungreased vessel, it coagulated in a few minutes. Moreover, contact with an ungreased glass rod sufficed to make the blood in the greased vessel coagulate outwards from the rod.

Further experiments showed that the drying of the upper layers of the blood, and the presence of small quantities of dust, caused coagulation even in the greased vessel; if this was guarded against, the blood remained liquid for days, and the corpuscles sank to the bottom, the plasma remaining as a clear liquid above.

After pouring out the blood, the greased walls of the glass vessel showed neither blood-colouring matters, nor traces of a separated albuminous body. A repetition of these experiments at 37° C. gave the same result. In all the experiments blood was also, for comparison, drawn off into ungreased vessels, and in all these it coagulated, at the most, in a quarter of an hour.

In further experiments a small vaseline-lined glass tube was used as a canula; and the blood drawn through this into vaseline-lined vessels also remained uncoagulated.

When the outer orifice of a canula inserted in the carotid was closed, the blood column in it pulsated, without showing the least sign of coagulation even after two hours.

In all these experiments there was nowhere in the vessels with which the blood came into contact even a point for adhesion—such a point would have caused in shorter or longer time coagulation of the whole mass of blood. Thus the coagulative influence of foreign bodies appears to be due to their adhesion.

But to demonstrate that the anti-coagulative property of the vascular walls is due to the lack of adhesion, a further series of experiments was made with soaked fish-bladders and parchment-tubes.

The membranes lay several hours in 0·6 per cent. chloride of sodium solution; the blood was drawn off through a vaseline-lined canula into the bladders and tubes, which were then so hung in a litre of the salt-solution that the mass of blood was under the surface. In these experiments also the blood remained liquid, the surrounding salt-solution having no coagulative effect, while some of the blood, poured after twenty-four hours into an ungreased porcelain vessel for comparison, soon coagulated. Like the blood-vessels, which, unlike manufactured vessels, after being emptied of the blood, retain no colouring-matter, the membranes, even after several days, showed neither imbibition with blood-colouring matter, nor any trace of coagulated fibrine. Thus, by soaking in salt-solution, a property of the blood-vessels was imparted to the fish-bladders and parchment-tubes.

It can hardly be doubted, then, that while, on the one hand, lack of adhesion prevents blood from coagulating, so, on the other, the presence of adhesion gives the impulse to coagulation.

[1] By Ernst Freund, in *Wiener medicinische Jahrbücher*, 1885, Heft 1.

INOCULATION AS A PRESERVATIVE AGAINST CONSUMPTION

M. VERNEUIL has lately published a letter to the editor of the *Gazette hebdominaire*, M. Lereboullet, in which he proposes to set on foot an experimental inquiry into the possibility of finding some method of "attenuating" the presumed *virus* of tubercle, so as to make inoculation therewith practically useful against consumption, either as a prophylactic measure, like vaccination against small-pox, or as a means of cure, like Pasteur's inoculations in hydrophobia.

Three thousand francs have already been subscribed, and the respectable names of Cornil, Bouchard, Damaschino, and Potain are mentioned among those who approve of the investigation.

It must however be remembered (1) that with the exception of hydrophobia, an exception still on trial, no human disease but small-pox is known which can be prevented by inoculation; (2) that of epizootic diseases anthrax is only in certain cases guarded against by Pasteur's attenuated virus; (3) that the dependence of consumption on Koch's *Bacillus tuberculosis* is far from established; (4) that its fatality is very far below that of small-pox or hydrophobia, and its treatment far more successful.

Consumption is the most important disease of temperate climates, both by its prevalence, its mortality, and its incidence on young adults; so that the sacrifice of a few rabbits or cats for even a remote chance of controlling its ravages is well justified. But the chance is, we fear, remote.

NOTES

THE friends and former students of Prof. P. J. Van Beneden, of Louvain, are about to celebrate there the fiftieth year of his professorship. Since the year 1836 this distinguished *savant* has occupied the position of Professor of Zoology at the Louvain University, and it is proposed to present him, on the occasion of his jubilee, with a gold medal bearing his portrait. After half a century of teaching and the accomplishment of a vast amount of other work, Prof. Van Beneden still remains fresh in mind and body. His writings have embraced with equal success various branches of biological science, and have gained for him a reputation of the first rank, which has just been crowned by the award of the Cuvier Prize by the Academy of Sciences of Paris. There is no doubt that the proposed demonstration to honour Prof. Van Beneden on his jubilee will find a ready echo in this country, where he possesses numerous friends.

IN a recent debate in the French Chamber of Deputies on a Bill permitting any person by will to regulate the conditions of his funeral, a clause was added at the instance of M. de Mortillet, the eminent anthropologist, enabling any person to dispose of his body in favour of educational or learned societies. M. de Mortillet stated that the Autopsy Society founded by Broca had been allowed to retain the brains of Gambetta, Dr. Bertillon, and two journalists, but the authorities might at any time take these away from its museum, as also any bones or skeletons. The proposition was adopted by 268 votes to 198.

WE are glad to receive a copy of the *Annual Companion to the "Observatory."* Its object is to give, in a collected form, the whole of those Ephemerides which have hitherto been printed month by month in the *Observatory*. This issue is regarded as an experiment, and the editors ask for suggestions for the improvement of future *Companions*, and for criticisms on the present one. In future it is intended to issue it with the December number or before. The principal sources from whence the Ephemerides have been derived are as follows:—The "Meteor Notes" have been taken principally from the valuable series of papers by Mr. Denning in vols. i., ii., and iii. of the *Observatory*, supplemented from the British Association *Reports*. Mr. Denning has also kindly revised them. The Ephemerides for the physical observations of Jupiter and Mars are derived by permission from those calculated by Mr. Marth, and published by the Council of the Royal Astronomical Society in the *Monthly Notices*. The Ephemerides for the satellites of Mars, Saturn, Uranus, and Neptune are taken from the *American Nautical Almanac*, corrected, in some cases, for recent observations made at Greenwich. The elements of occultations and times of eclipses of Jupiter's satellites are extracted from the English *Nautical Almanac*. The Catalogue and Ephemerides of Variable Stars are derived from the *Annuaire du Bureau des Longitudes*. The publication will certainly be of much practical value.

ON the evening of Wednesday, February 17, Prof. A. B. W. Kennedy and the Committee of the Engineering Society held a successful *soirée* at University College, London, in connection with the College Society. Visitors were received in the engineering laboratory, where machinery was in motion, and Mr. A. S. Ashcroft's autographic stress diagram apparatus was shown in action. All the available space was occupied with exhibits. The College Society organised a show of photographs and photographic apparatus in the library, where Messrs. Clarke and Clarke exhibited their method of printing by gaslight. The *soirée* was attended by about 1000 visitors.

LAST autumn the run of salmon up most of our rivers, especially those falling into the North Sea, was quite unprecedented. It is worthy of notice that at the same time (that is from August to November) they ascended, in equal, if not still more remarkable, numbers, the rivers that flow into the North Pacific Ocean, as well on the Japan side as the American. The "canning companies" in British Columbia were quite unable to obtain boxes and barrels quickly enough to keep pace with the supply, and fine large fish were sold for a cent apiece. Had this abundance of the Salmonidæ (sea-trout and bull-trout were as numerous in proportion as salmon) been confined to this part of the world, one might have supposed that an epidemic amongst dog-fish had enabled a much greater number of smolts to escape at the mouths of the rivers on their descent than commonly do; but under the circumstances some more satisfactory explanation seems to be required. Possibly in some manner the quantity of ice in northern waters on both sides of America had an influence upon these fish, or those that prey upon them in the deep water.

THE Italian Ministry of Agriculture has just undertaken an interesting experiment. Half a million of fish eggs were artificially hatched, and the young brood has been distributed all over the centre of the Lake of Como. If the experiment succeeds fairly well, it will be taken up on a large scale, and the department will undertake the re-stocking of the Italian waters. Efforts will be made immediately to revive and extend the rearing of lobsters.

THE old Tour St. Jacques la Boucherie, Paris, celebrated in connection with Pascal's experiments on atmospheric pressure, is now the site of a Laboratory of Physics. The inauguration took place on January 13. The tower was lighted by incandescent lamps.

LARGE sulphur deposits are reported to have been recently discovered on the southern slopes of the Caucasus.

ECUADOR was visited by natural calamities during January, which probably have been the cause of great loss of life. On January 12 the sky in and around Guayaquil was of a dark red colour, as if coloured by an immense conflagration. Detonations heard in the direction of Cotopaxi, and accompanied by earthquakes and subterranean noises, showed that some volcanic eruption was in progress. The noise and shocks lasted for two days and nights. At Yaguachi, opposite Guayaquil, a rain of ashes was observed. It is feared that the town of Latacunga, which is situated at the foot of Cotopaxi, is destroyed.

A REMARKABLE effect of lightning has been recently reported by Prof. L. Weber in a German serial. At Ribnitz, in Mecklenburg, during a violent thunderstorm, with rain and hail, about 6 a.m., the lower pane of a window on the first floor was broken by lightning, and a jet of water was thrown upwards through the aperture to the ceiling, where it detached part of the ceiling, and this, falling with the water, broke a small cigar-table below. Three bucketfuls of water were afterwards taken from the room. The hole in the window was like that from a bullet, and there were radial cracks. The path of the lightning is not very clear, but that it passed through the glass could not be doubted. Some cigars on the table, it may be mentioned, were carbonised. As to the jet of water, Prof. Weber rejects the hypothesis of a sudden generation of vapour forcing up water from the street. Another explanation offered is that the lightning, passing through the window to the street, generated a vortex of air about itself with vacuum in the interior, through which the water was driven as through a tube. A third hypothesis remains, viz. that a conical *trombe* struck the street, was reflected, and passed through the window in the form of a jet of water. In this case the lightning would merely have accompanied or preceded the *trombe*. Prof. Weber seeks further light on such phenomena.

ON the evening of January 9 a very fine display of the aurora borealis was seen in the southern parts of Norway.

A MAGNIFICENT meteor was seen by the station-master at Leangen Station, in the north of Norway, on January 16, at 8.15 a.m., it being still dark. He states that the meteor first looked like a small star, but, approaching with great velocity, soon attained the size of a cheese-plate. It had a dazzling white light, very like the electric, and was clearly visible, being below the clouds in the upper part of the sky. When it had passed the zenith and reached the eastern horizon, it separated into several parts, which gradually became extinguished. It left a trail for a few seconds, brownish-yellow in colour. Another meteor, to which we referred last week as having been seen at Aas, near Christiania, at 5.30 p.m. on January 5, was also seen in various other parts of the province of Smaalenene, even as far south as Frederikshald, near the Swedish frontier (distance from Aas about 100 kilometres = 63 miles). It appeared there in the constellation Taurus, at 5.15 p.m., and moved in a north-westerly direction. It left a long bright trail, and its passage was, according to some, accompanied by a faint hissing.

ON New Year's Eve an earthquake was felt in the central parts of Norway, particularly at Elverum and Löiten, where the houses shook. Another shock was felt in the province of Christiansand, at about 4 a.m. on January 16, followed by vivid flashes of lightning. In several houses the doors sprang open, and furniture, &c., was moved. A girl was thrown out of bed in one place. The barometer was very low at the time, but remained the same as on the previous day.

PROF. LOMMEL has recently described (*Wied. Ann.* 1) an aërostatic balance for determining the specific gravity of gases. It is useful for lecture experiments. Under one scale of a balance is hung, by means of a wire, a closed glass balloon, which is inclosed in a glass vessel having in its cover a small hole for the wire. This vessel has a side tube, with stopcock, near the bottom. The instrument being balanced while air is in the vessel, another gas is allowed to stream in and displace the air, whereupon the balloon rises or sinks according as the gas is heavier or lighter than air. By adding weights in one scale or the other equilibrium is restored, and one finds how much more or less a volume of gas equal to that of the balloon weighs than the same volume of air at the same temperature and pressure.

WE have received the Calendars of the University College of Aberystwith and Cardiff for the Session 1885-86, and the reports of work in both cases are very satisfactory, showing, as they do, a considerable increase in the number of students, and in the general scope of the educational work. We have examined with especial interest the Aberystwith Calendar, for it will be remembered that during last summer the College there was almost wholly destroyed by fire. The Council met the situation by taking a large hotel, where the work of the institution is carried on apparently without any serious inconvenience. The Principal of this College calls attention to a question which requires the careful consideration of the responsible authorities of the three University Colleges of Wales, and which, for the sake of the equitable distribution of the prizes and scholarships of these institutions, it is to be hoped may speedily be settled. Principal Edwards points out the danger that healthy and legitimate rivalry between the Colleges is in danger of degenerating into a bid for students by the offer of money bribes, and he quotes the case of a student who wandered from one to the other, taking scholarships at all three by recommencing his course at each in succession. There is apparently no regulation preventing a graduate of one beginning as an undergraduate at each of the others, and carrying off the prizes to the disadvantage of *bonâ-fide* students. Unfortunately, the negotiations which have been undertaken to prevent this grave abuse have hitherto proved unsuccessful, but it behoves the authorities concerned to prevent this misapplication of money so nobly subscribed for education by all classes of the Welsh people. Two very interesting and suggestive tables will be found at page 25 of the Aberystwith Calendar. The first gives the ages of the students: 76 are over 20 years of age, 22 over 25, and 5 over 30. The second contains the occupations of the parents, and shows in the most marked way the struggles which, to their infinite credit, Welsh parents make to educate their children. This trait in the Welsh character is well known, but we have not seen it exhibited in this definite, concrete manner before.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Miss Douglas; a Chacma Baboon (*Cynocephalus porcarius* ♀) from South Africa, presented by Mr. F. Radcliffe; a Ring-tailed Coati (*Nasua rufa* ♀) from South America, presented by Miss A. Pagella; an Orange-winged Amazon (*Chrysotis amazonica*) from South America, presented by Mr. G. F. Richards; two Feline Douracoulis (*Nyctipithecus vociferans*), two Silky Marmosets (*Midas rosalia*), a Razor-billed Curassow (*Mitua tuberosa*), a Mantled Buzzard (*Leucopternis palliata*) from Brazil, a Raccoon (*Procyon lotor*) from North America, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE NEW STAR IN THE GREAT NEBULA IN ANDROMEDA.—As the *Nova* in Andromeda was the first object of its kind to which accurate photometric methods of observation were applied, Prof. Seeliger of Munich has taken the opportunity of investigating whether the observed variations of brightness throw any light on the physical history of the phenomenon. If we suppose that the surface-temperature of a "new" star is suddenly increased by an enormous quantity, and, in consequence, the brightness increased to a corresponding extent, and assume that the latter is proportional to an arbitrary power, n, of the temperature, then the light curve constructed from the observations will be a curve which represents the nth power of the successive temperatures of a cooling body. Prof. Seeliger has deduced an expression for the temperature of a sphere at any time, t, on the assumption that the sphere is homogeneous with respect to the conduction of heat, that at the time $t = 0$ it has the same temperature throughout its interior, and that the temperature of the surrounding medium is zero. If, then, h be the brightness corresponding to a temperature θ, we have $\theta = h^{\frac{1}{n}}$, and using Pogson's scale for transforming brightness into stellar magnitude, there results a formula for the magnitude of the cooling star at any time. For the purpose of comparing his formula with Herr Müller's photometric observations of the *Nova*, extending from 1885 September 2 to October 13, Prof. Seeliger assumes that $n = 1$, and that the epoch for which $t = 0$ is 1885 August 27d. 8h. Berlin M.T. He also uses quite approximate values for the constants involved in his formula, the more accurate determination of which would be a work of difficulty. Under these circumstances he gets a very fair agreement between the observed and computed values, which would, he considers, be improved by using more accurate values of the constants, and of the epoch for which $t = 0$. The magnitude corresponding to this latter epoch is 7·73. Considering that there is evidence to show that the Andromeda nebula is, in part at least, a star-cluster consisting of a vast number of faint stars, Prof. Seeliger thinks it not improbable that the blazing forth of the *Nova* may have been due to a collision which caused an enormous development of heat and light. At all events, the fact that his formula represents the observations tolerably well appears to him to be sufficient evidence to show that the supposed conditions are not, in the main, at variance with the actual circumstances of the case.

PRESENT STATE OF THE SOLAR ACTIVITY.—The sunspot maximum, after some remarkable oscillations, was definitely attained about the close of 1883, the interval from the period of minimum having been nearly two years longer than usual. Since that date there has been a steady diminution in both the numbers and areas of the sunspots. M. R. Wolf gives (*Comptes rendus*, vol. c. No. 3, and vol. cii. No. 3) the following values for his relative numbers for the last three years: 1883, 63·7; 1884, 63·3; 1885, 50·3. The diminution in the last part of 1885 was particularly marked, there having been a vigorous rally in the months of May, June, and July, followed by a rapid decline. The relative numbers for the last three months of the year fell far below the mean of the twelvemonth. The figures given by M. Tacchini closely correspond to those given by M. Wolf, as the following table will show. The last three columns give Tacchini's numbers:—

1885	Wolf's numbers	Relative frequency	Relative size	Daily number of groups
January	31·4	19·57	43·19	4·33
February	67·2	23·81	77·33	5·96
March	46·6	16·23	44·92	2·92
April	54·6	15·10	56·86	3·48
May	80·5	18·68	86·21	5·80
June	82·1	22·36	132·76	5·21
July	61·4	15·41	90·22	4·45
August	47·7	11·20	44·70	3·40
September	43·4	9·14	59·20	3·31
October	42·6	12·55	55·64	3·09
November	26·8	6·35	22·90	2·30
December	18·9	4·84	21·44	2·12

Faculæ have not shown so rapid a decline, but there has been a distinct falling off in these also; the difference, however, is at present noticed rather in a loss of brilliancy than of apparent area. But hitherto the prominences have shown but slight indications of a participation in the falling off so strongly exhibited by the spots. The following numbers, derived from papers by the Rev. S. J. Perry in the *Observatory* for February 1885 and 1886, show indeed a slight increase of energy for 1885 over 1884:—

Year	Mean height of chromosphere, excluding prominences	Mean height of prominences	Mean extent of prominence arc
	"	"	° ′
1880	7·93	23·46	23 21
1881	8·04	24·61	33 18
1882	8·24	24·55	40 57
1883	8·27	27·23	41 24
1884	7·94	25·74	29 6
1885	8·00	28·67	28 25
Mean 1880–1885	8·07	25·71	32 45

The mean extent of prominence arc is thus the only element which seems to point to the maximum being past.

But if the prominences do not show any close correspondence to the behaviour of the spots, M. Wolf finds that the variations of magnetic declination have responded to their changes fairly closely. In the paper alluded to above he gives, side by side with his "relative" spot numbers, the monthly means of the variations in magnetic declination as observed at Milan. The mean observed value for 1885 is 7′·95, whilst 7′·88 is the mean value computed from the formula M. Wolf had deduced in former years for Milan, $v = 5'{\cdot}62 + 0{\cdot}045\ r$, where r is the relative sunspot number for the year.

Prof. Spörer points out (*Comptes rendus*, vol. ci. No. 26) that the spots have not been equally distributed between the two hemispheres during the period of maximum, but that throughout the years 1883, 1884, and 1885 there has been a nearly constant predominance of southern spots over northern; whereas in the period from minimum to the end of 1882 the predominance rested, on the whole, with the northern hemisphere. This alteration has also been accompanied by somewhat of a check in the regularity of the progress of the spots towards the equator, which is usually so marked in the interval from one minimum to the next.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 FEBRUARY 28—MARCH 6

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 28

Sun rises, 6h. 49m.; souths, 12h. 12m. 41·5s.; sets, 17h. 36m.; decl. on meridian, 7° 52′ S.: Sidereal Time at Sunset, 4h. 10m.

Moon (New on March 5) rises, 3h. 39m.; souths, 8h. 6m.; sets, 12h. 34m.; decl. on meridian, 18° 16′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	7 5	12 28	17 51	7 59 S.
Venus	5 28	11 4	16 40	5 19 S.
Mars	18 7*	0 53	7 39	8 23 N.
Jupiter	19 41*	1 45	7 49	0 4 S.
Saturn	11 21	19 32	3 43*	22 45 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

March	h.	
3	5	Saturn stationary.
5		Annular eclipse of the Sun; not visible in Europe.
6	12	Mars in opposition to the Sun.
6	18	Mercury in conjunction with and 0° 8′ north of the Moon.

Variable-Stars

Star	R.A.	Decl.		
	h. m.	° ′		h. m.
U Cephei	0 52·2	81 16 N.	Mar. 3,	20 57 *m*
Algol	3 0·8	40 31 N.	Feb. 28,	23 24 *m*
			Mar. 3,	20 13 *m*
λ Tauri	3 54·4	12 10 N.	,, 2,	18 12 *m*
R Lyncis	6 51·9	55 29 N.	,, 2,	*M*
ζ Geminorum	6 57·4	20 44 N.	,, 4,	21 30 *M*
V Geminorum	7 16·8	13 19 N.	,, 6,	*M*
δ Libræ	14 54·9	8 4 S.	,, 4,	22 36 *m*
U Coronæ	15 13·6	32 4 N.	,, 5,	20 13 *m*
V Coronæ	15 45·5	39 55 N.	,, 5,	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 3,	5 28 *m*
			and at intervals of	20 8
X Sagittarii	17 40·4	27 47 S.	Mar. 3,	0 0 *m*
			,, 5,	21 30 *M*
W Sagittarii	17 57·8	29 35 S.	,, 6,	21 30 *M*
β Lyræ	18 45·9	33 14 N.	,, 6,	0 0 m_2
δ Cephei	22 24·9	57 50 N.	,, 3,	0 0 *M*
R Aquarii	23 37·9	15 55 S.	,, 3,	*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor Showers

The first week in March furnishes the most favourable nights of the month for meteor observation, but none of the great periodical showers occur at this time. Amongst the radiants represented are the following:—

Near γ Orionis, R.A. 80°, Decl. 6° N.; near α Persei, R.A. 50°, Decl. 48° N.; near η Boötis, R.A. 205°, Decl. 17° N.; near ξ Sagittarii, R.A. 280°, Decl. 17° S.; Ursa Major, R.A. 180°, Decl. 60° N.

BIOLOGICAL NOTES

CONTINUITY OF PROTOPLASM.—M. L. Olivier proposes, in the *Comptes rendus*, the following methods for determining the connection between the protoplasmic contents of adjacent cells:—(1) Photography. This distinctly reveals the perforation by canals of the cell-walls, when photographed direct with a magnifying power of 300–700 diams. (2) Direct observation, with powers magnifying from 700–900 diams. Though successful in some instances, this method is for the most part wholly insufficient. (3) Staining sections. This was successful in many plants in demonstrating the protoplasmic connection. (4) Injection into organs. When injected slowly, under pressure, with a fluid capable of colouring protoplasm, if the injection took place in a sufficiently uniform way, the canals were rendered visible. By the methods thus indicated continuity of protoplasm was established in the stem and leaves of the box-tree, and in *Ficus elastica.*

NEW EDIBLE FUNGUS.—Mr. Colenso calls attention to the rapidly-increasing value as an article of export from New Zealand of *Hirneola polytricha.* This mushroom, first described from the East Indies and Java by Montagne, is of various sizes and shapes, some specimens measuring even a few inches. It is found in New Zealand growing on the trunks of trees, both on living and on decaying ones, especially on the latter while standing, particularly on the stems of *Corynocarpus lævigata* and on *Melicytus ramiflorus.* Both of these are endemic. The former is mostly confined to the sea-shore, where it often forms dense and continuous thickets. The latter tree is scattered plentifully throughout the country. When dry, the mushroom becomes shrivelled up, and is as hard as horn; when wet, it is soft and elastic, almost subgelatinous. It grows in compact gregarious masses. The market for this fungus is China, where it is largely used by the Chinese in soups. It appears that another species of the same genus indigenous in North China has long been an article of commerce. Mr. Berkeley notes of our British species, *H. auricula-judæ,* that it was once a popular remedy for sore throats, and adds that it is still occasionally sold at Covent Garden Market. The New Zealand species is plentiful, and obtained at little cost, the drying of it being an easy matter. Originally the price paid to collectors was a penny per pound; now it is nominally twopence halfpenny, while its retail price in China is five times this. The *declared* value per ton at the Customs ranges from 33*l.* to 53*l.* a ton, and is doubtless much below its real value. During the last twelve years some 1858 tons of this fungus were exported, chiefly from the ports of Auckland and Wellington, and of a declared value of almost 80,000*l.*—(*Trans.* Penzance Nat. Hist. and Antiq. Soc., 1884–85.)

WORMS IN ICE.—Prof. Leidy had examined a block of ice which was part of the stock of ice stored at Moorestown, N.J., and had been nearly a year in store; it was full of air-bubbles and water-drops. On being melted a number of worms were liberated, and proved to be in a living and quite active condition. It is probable that while imprisoned in the ice they may not have been frozen, but perhaps remained alive in a torpid state in the water-drops; but it seems remarkable that these animals should remain so long alive in the ice, and yet die, as they did, almost immediately, in the melted ice-water. Of course the fact points to the advisability of not employing spongy ice as an article of food. Dr. Leidy, believing the form to be as yet undescribed, gives a diagnosis of it under the name *Lumbricus glacialis;* it is from 4 to 6 centimetres long, of from 35 to 50 segments; oral segment unarmed, eyeless; succeeding segments with four rows of podal spines, in fascicles of three.—(*Proc. Nat. Sci. Philadelphia,* December 22, 1885.)

STAR-FISHES FROM SOUTH GEORGIA.—Dr. Studer describes a small collection of star-fishes made by Dr. v. d. Steinen, the naturalist of the German Polar Expedition in 1882–83, who had a meteorological station at South Georgia. Of the 14 species collected, 9 belonged to the family Stelleridæ, and 7 of these were new, 5 to the Ophiuridæ, of which 4 were new. Most were collected in quite shallow water. The general character of the fauna is like that of Kerguelen Land; and, to assist the comparison, Dr. Studer gives a comparative list of the known species from the South American (Falkland Islands, Magellan Straits) district and that of Kerguelen Land. All the new species are well figured in two plates which accompany the memoir.—(*Aus dem Jahrbuch der wissens-Anstalten zu Hamburg,* xi. 1885.)

GEOGRAPHICAL NOTES

THE last number (15) of the *Journal* of the Straits Branch of the Royal Asiatic Society contains several papers of much geographical interest. In the first, Mr. Swettenham describes a journey across the Malay peninsula from Kwala Bernam in Perak, through Pahang to Kwala Pahang on the east coast. The paper is in the form of a journal, but, unfortunately, the accompanying sketch-map is so defective as to be quite useless to assist the reader in following the narrative. Père Couvreur, of the Missions Etrangères at Singapore, contributes an account of a recent journey through Laos from Bangkok to Ubon, a town on the Szimûn, a tributary of the Mekong, including a visit to the ancient Khmer city of Puthai-Saman, the monuments and architecture of which make it similar to the renowned Angkor, but on a reduced scale. To the people of the country these magnificent ruins are the work of avals, so completely has all trace of the great civilisation of which they are the eloquent witnesses disappeared from Cambodia. This paper is also in the form of a journal, but is not accompanied by a map. There are several other papers of interest (such as the translation of old Valentyn's account of Malacca, and the account of the Dutch expedition of 1877–79 to the interior of Malacca), but these are not original to the Straits Asiatic Society.

THE *Verhandlungen* of the Berlin Geographical Society just published (Band xiii., No. 1) contains an account, by Dr. Wolff, of the journey of the expedition sent out by the African Society in 1884 from San Salvador to the Quango and back, and Dr. Diener writes on the mountain system of Lebanon, on which he has also a paper, already noticed, in the February *Petermann.* The current *Zeitschrift* (Band xx., Heft 6) of the same Society is largely occupied by a bibliography of the works, papers, maps, &c., relating to geography published during the year ending November 1885. There is, however, a curious list of the lengths and drainage areas of 376 rivers of the world. These figures are necessarily approximate only in most cases. It is noticeable that, while the Mississippi is 5882 kilometres in length, and the Amazon only 4929, the drainage area of the former is less than half that of the latter, the figures being: Mississippi, 3,201,545, and the Amazon 7,337,132, square kilometres. The only other paper in the number is an exceedingly interesting one by Herr Rohde, on the Terenos tribe, which inhabits the district to the west of the Brazilian town of Miranda, and stretches as far as the Bolivian frontier. They are really Chaco Indians who have migrated from Bolivia. The writer describes, all too briefly, their appearance, mode of life, occupation, and customs—especially their festivals.

THE Austrian traveller, Mr. C. Hermann, who started on a West African exploring tour in April last, has returned to Vienna. Having visited Liberia, Cameroon, Eloby, Gaboon, and other points on the coast, he arrived at the Congo early in July, and expected the arrival of Dr. Lenz at Banana. In order to engage the necessary porters for Dr. Lenz's expedition he went to Loango, but returned to Banana without having succeeded. He left Dr. Lenz on October 20 and returned to Europe.

DR. BERNHARD SCHWARZ writes from Monrovia (Liberia), under date January 23, as follows:—"As chief of an official expedition 'for the investigation of the up-country districts of Cameroon,' I reached Cameroon on November 6 last, and thence I proceeded eastwards with forty Bakwiri porters (from the Cameroon Mountain) on the large main road leading to the interior over the magnificent slopes of the Cameroon Peak. I penetrated through the immense virgin forests, which are peopled with elephants, and in which coffee, india-rubber, &c., grow, and and safely reached the interior of our colony, never before visited by a white man on account of the energetic resistance offered to all traders by the natives. Here live the Bafarami in the Bafon Land, hitherto not even known to the world by name. They cultivate the soil and keep cattle, and are comparatively civilised. I visited Kumba and Kimendi, their large towns, but on account of an attack made upon us by 500 armed slaves I could not see the upper Calabar, whieh must have been quite near. The maps hitherto existing of this interesting district, which may be of the highest importance for the whole future of our colony, are either insufficient or else quite wrong."

THE SUN AND STARS[1]

WHEN we have to consider the stars taken in their entirety, it is obviously convenient that we should begin with the sun, because in that way we shall be enabled to go outwards from the known; since it is easily to be understood that it is within

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes.

our power to know very much more about the sun, which is the star that lies nearest to us, than about the other stars, so far as detailed structure, at all events, is concerned, for the reason that the sun, although actually so far away, is relatively very near to us.

The Sun's Distance[1]

The distance of the sun we may take to be about 93,000,000 of miles, and, although that seems a long way in terrestrial reckonings, twice that distance is the smallest base line which astronomers can use in dealing with the distance of the star which is next nearest to us, to say nothing of the millions of others more remote. The sun, from being relatively so near to us, appears as a body of a different order. The stars proper, however powerful the telescope with which we regard them, appear to us as the finest points imaginable, whereas the sun gives us the appearance of a circular disk, this disk being the projection of a sphere. That part of the sun with which we are most familiar is in fact a sphere of something like 860,000 miles in diameter; hence, taking the diameter of this world of ours roughly at 8000 miles, the diameter of the sun is more than 100 times as great.

The moon, the nearest celestial body to us, journeys round us at the relatively small distance of about 240,000 miles. The

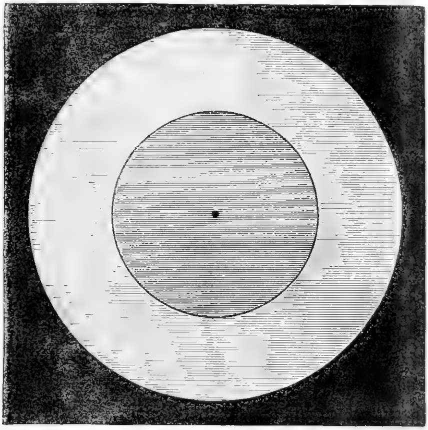

Fig. 1.—The orbit of the Moon and the circumference of the Sun compared.

accompanying drawing will enable us to compare the orbit or path of the moon round the earth and the space which it incloses, with the actual circumference of the sun (Fig. 1).

In the centre we have the earth very much larger than it ought to be, and the inner disk represents the space included in the orbit of the moon. The outer one represents the disk of the sun; so that it is clearly seen that if the sun were a soap bubble it would be quite easy for the earth's attendant satellite, the moon, to carry on its revolution inside it; in fact the orbit of the moon would not lie very much past half-way from the centre of the earth to the circumference of the sun.

The Sun's Envelopes

The next point which has been made clear by the work of the last quarter of a century, let us say, is that this central nucleus which we see ordinarily and call the sun, is only, after all, a very small part of it. Outside it there is a shell very exquisite in colour. This might be described as a sort of sea surrounding the central nucleus, if that expression did not give the idea that the nucleus itself was a solid, which it is not.

This first envelope, the *chromosphere*, as it is called, represents a sort of atmosphere or sea surrounding what is named the *photosphere*, to a height varying, say, from 5000 to 10,000 miles. I have said that it is exquisite in colour. It is of an intensely brilliant pearly white at the base, and of a magnificent scarlet, as a rule, higher up. But this is not the outside of the sun by any means. Further from the centre, again, there is another region, which we may call the inner corona, overlying the photosphere and chromosphere; the height of this atmosphere—I mean the distance from the top of it on the average down to the photosphere—we may again roughly take at something like 100,000 miles. Not very many years ago, in the text-books we were told that the earth's atmosphere only extended to a height of 50 miles, so that it can be easily recognised that we are dealing with an atmosphere on a very large scale indeed when we come to touch the sun.

These portions of the sun's atmosphere are only very rarely seen under the best conditions. We can feel, so to speak, the lower reaches every day in our observatories, but we can only see them when the sun is eclipsed. When, in an eclipse, we can get a good sight of the inner corona, what we see is very beautiful indeed, because we not merely get a pearly shell of light, which, roughly speaking, may be taken to be 100,000 miles high, but we see stretching into it from and through the chromosphere beautiful and curious objects called "red flames," or "prominences," or "protuberances."

Have we yet finished with the solar envelopes? No; there is still another. There is still an upper atmosphere, and to this I must ask you to give a height of anything you like between half a million of miles and a million and a half; and I speak thus indefinitely for the reason that the exact limit is at the present moment occupying those who are concerned in these matters. The limit of course you will understand is a limit which can only be determined during eclipses. Now the sun is only eclipsed for something less than a week in a whole century over the whole earth, and I suppose that if an observer of eclipses were to give his whole time to them he could not spend more on the average than six minutes every two years, so that the time is not excessive in which the astronomer either has to make observations or to make up his mind as to what he sees. You must not, therefore, be surprised when I give you this large choice. If we call it roughly a million of miles, we at all events shall not be very far off the truth, even supposing the height to be constant; but it would appear indeed that the height varies every time we have a chance of observing it. On that point we shall have a great deal to say further on.

When we come to this outer atmosphere, we pass from one with a more or less concentric boundary, to one with a most irregular outline, full of strange forms varying in an almost inexplicable manner from eclipse to eclipse.

In the eclipse of 1878 one of the observers who took special precautions to shield his eye from any brighter light at the moment that the eclipse took place, imagined, or saw, the fainter portions of the solar corona, or some solar surrounding, extending to several diameters. The outer corona is not only very strange in its appearance, but wonderful in colour, and full of detail for a considerable distance from the dark moon.

To sum up some of the principal points—by no means all of them—we may say, first, that its outline is very irregular; that there seems to be a flattening, or very often two opposed flattenings, at opposite ends of a solar diameter. This tends to make the thing look very often more or less square. In all parts of it, irregularly (by which I mean that you cannot predict quite where they will be), you get radial rifts in which the light is much less intense than elsewhere.

I have, then, indicated that the sun that we see is not the whole of the sun. Hence, when we study the stars we shall probably find that we have not only to take into account the phenomena presented by the sun as we ordinarily see it, but others associated with those parts of the sun which are only revealed to us from time to time, and the possibility that such phenomena as we see on the sun may be enormously intensified in other bodies.

The Sun's Rotation

The next question that we have to put concerning the sun is this:—Since it is a sphere as the earth is, and since the earth rotates on its axis, does the sun rotate on its axis? How are we to answer that question?

[1] The most recently determined value of the sun's distance depends upon Prof. Newcomb's determination of the velocity of light. This velocity Prof. Newcomb values at 299,860 kilometres per second, with a probable error of 30 kilometres either way. Combining this with Nyrén's value of the constant of aberration 20″·492, the solar parallax = 8″·794, which gives a distance of 149·61 millions of kilometres. This equals 92,965,020 British statute miles.

in this way. Sometimes when we look at the sun it is a beautifully pure hemisphere, almost equally illuminated all over it with the exception of a darkening towards the edge, about which more presently; but at other times these conditions are altered. It is more or less covered with what are called spots. It is more than two centuries and a half ago since it was clearly demonstrated that these spots belong to the sun itself; and it will be clear, therefore, that if these spots really do belong to the sun, or, to be more precise, are phenomena occurring in the photosphere—which is the part of the sun which we usually see, the rotation of the sun will be demonstrated if these spots are found to travel regularly across its disk; whereas its fixity will be demonstrated if we find that the spots do not move at all. A very great deal of work has been done in this direction, and it has been determined beyond all question that the sun does rotate like the earth and like the other planets of our system, and that it rotates from west to east, contrary to the hands of a watch, as the earth does.

We next have to consider the plane of this rotation. The earth moves round the sun in a plane which we call the plane of the ecliptic; but we know that the earth does not rotate in this plane. There is a difference of $23\frac{1}{2}°$ between the equatorial and ecliptic planes. We therefore say that the earth's axis is inclined $23\frac{1}{2}°$ to the plane of the ecliptic. Further, if we wish to know the particular direction in which it is inclined, we must determine the longitude of the ascending node, and this done, we can determine the star towards which the earth's axis points.

Well, can we get out these facts with regard to the sun? Yes. The sun does not rotate in the plane of the ecliptic as we might first of all imagine that it would do. Its axis is inclined at about 7° to that plane, and its ascending node does not lie in the same direction in space as the ascending node of the earth, but it is distant from it some 73°. We have two very accurate determinations of these two sets of data. Carrington's first value gives—

	°	′
Longitude of node	73	40
Inclination	7	15

We see, although the sun's rotation does not take place in the plane of the ecliptic, it does not take place in a plane very far removed from it.

Spörer, a German observer, who has taken up this question since Carrington, makes some very slight changes. He gives—

	°	′
Longitude of node	74	36
Inclination...	6	57

The right ascension of the star towards which the sun's pole points is 18 hours 14 minutes, and its declination 64° N. It lies half-way between our own pole star, and the bright star *α* Lyræ.

We may now carry these considerations a little further. When the earth passes through the nodes of the sun's equator, that is

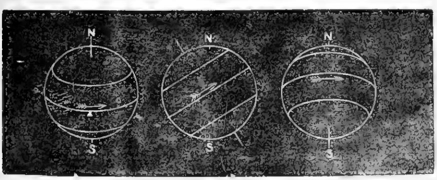

Fig. 2.—Position of the Sun's axis, and apparent paths of the spots across the disk, as seen from the Earth at different times of the year. The arrows show the direction in which the Sun rotates. The inclination of the axis is exaggerated, so that the effect produced may be more clearly seen.

to say, when the axis of the sun is at right angles to the line joining the centre of the sun and the centre of the earth, it will be perfectly clear that the spots will appear to travel straight across the disk. The two times of the year in which this occurs are June 3 and December 5. The two poles of the sun at those times are in fact on the sun's limb, and it is that condition really which makes the path straight (Fig. 2).

From June 3 to December 5 the north pole of the sun is gradually moving earthward. It will be clear, therefore, that during that time the spots, instead of travelling in straight lines across the disk, will gradually have their paths curved with the convexity downwards. When we have got to December, from that time to the next June it is the south pole that will be inclined towards the earth; and therefore the spots will then move with the convexity of their paths upwards.

So far I have said nothing about the period of the rotation of the sun. The question of the sun's rotation is not quite such a simple matter as it might appear at first sight. Here we must be quite honest to the first workers, and I must tell you that the actual facts appear to have been clear to a man who lived three centuries ago—Scheiner—who was the first to observe the spots with any very great and continuous care; he made what appeared to him the extraordinary discovery that the spots which were nearest to the sun's equator appeared to travel at a quicker rate than those which were nearer the sun's poles. The average time in which the spots appear to cross the sun is about 28 days. That you will understand is what we may term the

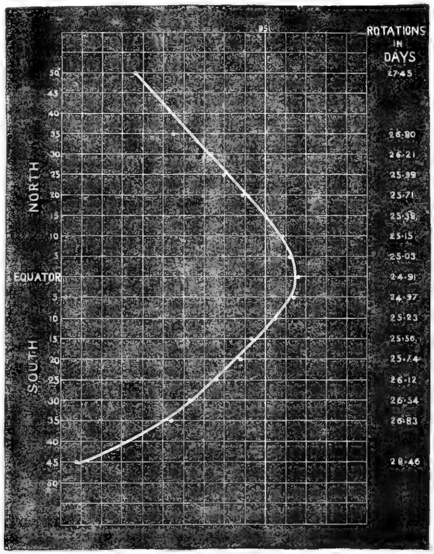

Fig. 3.—Curve showing the period of rotation of the photosphere in different latitudes north and south from Carrington's observations; 851′ of solar longitude per diem = rate of rotation in lat. 15° N. The vertical lines represent differences of 10′ of longitude, + to the right, − to the left, of the line cutting the curve in lat. 15° N.

synodic period, because the observations are made from the earth, which is moving in the same direction as the spots while the observations are being made. Making the correction for the movement of the earth, and getting the actual period, the 28 days have to be brought down to something like 26 for an average spot. Carrington, whose results for the plane of rotation I have already stated, also paid very great attention to this point, and to his work, and also to Spörer's, we owe very much of our present knowledge on this subject.

Carrington, from the observation of some thousand spots, came to the conclusion that the photosphere in which these spots are supposed to float really moves more rapidly at the equator than it does away from it, in the manner that Scheiner had suggested, in such a way that the movement at the equator really takes place in, as near as may be, 25 days, perhaps a little less; but that in latitude 30° there is a slackening off of a day and a half, so that it takes a spot in latitude 30° north or south not 25 days, but $26\frac{1}{2}$ days to make its movement right round; if we go as high as latitude 45°, we have to add on still another day, and then we find that the rotation takes $27\frac{1}{2}$ days.

Several distinguished men have endeavoured to formulate a law, a mathematical statement, by which, given the movement in one latitude, we may determine it for all other latitudes, and several of them have very nearly succeeded in doing it; but they all confess that it does not amount to much at the end of the chapter; by which I mean that the formula after all contains no physical basis. It is what is termed an empirical formula.

The formulæ to which I have referred may be given in this place. In them all x = daily motion in minutes of solar longitude, and l = latitude. They are as follows:—

Carrington ... ... $x = 865' - 165' \sin \frac{7}{4} l$

Faye ... ... $x = 862' - 186' \sin^2 l$

Spörer ... ... $x = 1011' - 203' \sin (41° 13' + l)$

Zöllner ... ... $x = \frac{863' - 619' \sin^2 l}{\cos l}$

Certainly we have here, as I think I shall be able to show you by and by, one of the points in the mechanism of the sun which it behoves those interested in solar physics to work at with the utmost diligence.

We have now got the fact that the sun, like the earth, rotates on its axis; that the inclination of its axis to the plane of the ecliptic is much less than the inclination of our axis; that its node lies in a different longitude; and that the photosphere, instead of being a solid thing like the surface of our earth, is a something which makes its journey round the sun's centre in $2\frac{1}{2}$ days less time in the central portions than it does half-way between the equator and the poles.

The Sun's Density

Now then let us come to another point. We are accustomed, in dealing with the earth and comparing it with other planets, to refer to the density of the various bodies. We say, for instance, that the density of the earth is $5\frac{1}{2}$ times greater than the density of water; that is to say, that the earth put in one scale would weigh down $5\frac{1}{2}$ earths of the same size, if they were made of water, put in the other. And we say, further, that the density of the earth is about the same as the density of Venus and of Mars; but the density of the other planets is very much less. We know on the earth that water is less dense, for instance, than mercury. We know that spirit is less dense than water. We can, indeed, put water in a tumbler, and by proper means add the spirit so that it will float on the top of the water. We do not generally do that. Again, we put lead into water, and it sinks. We put a cork into water, and it floats. All these represent different orders of density. The same thing happens with regard to gases. We know that hydrogen is less dense than oxygen and nitrogen, and so on.

Now, what is the density of the sun? Is the sun denser than the earth? No; according to the books it is just about a quarter as dense as the earth, so that it is a little denser than water. In fact, if we take water as our unit of density, if water equals 1, the density of the sun is 1·444. If we take the density of the earth as 1, then the value is about 0·25—practically, a quarter.

Now, these are the values given in the books, but I think that possibly we must call them in question. They have been determined by taking the volume of the sun as given by the diameter of the photosphere—860,000 miles. Now, we have had to concede 100,000 miles for the height of one atmosphere above the photosphere, and 1,000,000 miles for another, and it is not fair that those atmospheres should be left out of consideration. If we include these atmospheres, though we do not alter the mass, we alter the volume. If we put the same mass into a bigger volume, we naturally reduce the density. Now, if we take the atmosphere of the sun as extending to 100,000 miles above the photosphere, that will give us a radius of 530,000 miles, instead of 430,000 miles, and we shall, as nearly as may be, double the sun's volume. Therefore we shall have halved the density. Instead of being a quarter as dense as the earth, it will only be one-eighth as dense; and, instead of being just denser than water, it will be a little over half the density of water. For my own part, I think that this 100,000 miles is not sufficient. I think that it is the minimum. I think that most students of solar physics would agree that a height for this purpose of 500,000 miles above the photosphere would be probably nearer the mark. That will give us exactly ten times the volume of the sun bounded by the photosphere, so that the densities will be reduced to the tenth; we shall get a density then of about one-eighth of water. This, of course, is the average density; it is the density of the whole volume in which the mass is supposed to be diffused—the mass which is a fact which we cannot get out of, and which has a definite relation to the mass of our own earth. Now if these arguments are of any value we must concede that the density of the sun is very low indeed, much lower than that of any planet or satellite with which we are acquainted; so that we are perfectly justified in saying that it is an enormous globe of gas, by which I do not mean that it is absolutely and completely gaseous to the core. The gases of the centre—gases under very great pressure—may put on the appearance, if they do not put on all the physical properties, of liquids; but be this as it may, in any region that we can get at, unfortunately limited to something like 400,000 miles away from the centre, we are undoubtedly dealing with masses of gas.

The Sun's Heat

Another point in which we find an enormous difference between the sun and any other body that we investigate in the solar system is this—that the sun is an *intensely heated* globe of gas. It is of no use to use any adverbs to tell you how hot it is, and, unfortunately, there are very few available facts; so that I must ask you to give your imagination play, and to believe that it is very, very hot. The values that have been suggested by various men of science vary between 18,000,000° and 3000°. You may take your choice. The fact is, I think, that we are not yet in a position to find out the very best method of determining the solar temperature and then marking it down in an absolutely perfect manner, for the reason that the more one knows about the problem, the more one sees how terribly complicated it is.

No doubt we have here a field of work of the very highest interest. Of course, when men of science have stated that the temperature of the sun is 18,000,000° or 3000°, they have referred to the temperature of that part of the sun which is available to our observation, and to the hottest parts of it. Naturally, if the sun be a heated globe of gas, on the outside it must be cool, so that they do not mean that this globe of gas is equally heated throughout, but that the hottest part of it—the part which sends us the effective heat which we try to measure—is at that temperature.

There is one other very interesting question connected with the remark that the atmosphere must cool to the outside. This time last century the idea was that the sun was a habitable globe just like the earth. An intense heat and light were granted to an exterior envelope, but it was imagined that there was a reflecting stratum inside which sent all the heat away earthward, and planet-ward, and star-ward with redoubled energy, while at the same time it shielded the inhabitants who were below this reflector from the direct light and heat of this envelope. That was Sir William Herschel's idea. We know now that these things cannot be so. If the walls, and ceiling, and floor of this lecture theatre were incandescent, you may depend upon it that, in spite of any number of reflectors we should soon be incandescent too. According to what is now known as Prevost's theory of exchanges, anything inside a heated chamber must, if you give it time, get to the temperature of the walls of that chamber, for the reason that the walls would be giving heat to the object inside, and the object would be sending the heat back again if it had a surplus of it, and you would get this exchange going on until the temperature of everything inside would be the same as the temperature of the envelope; so that we are now perfectly certain that, if the temperature of the photosphere of the sun, let us say, be 3000°, or 30,000°, or 3,000,000°, the temperature of the internal part of the sun will not be less. It may be much more. So that we have to give up all that beautiful idea of the habitability of the sun by creatures like ourselves.

Now, if this mass of gas, a million and a half of miles in diameter, let us say, is coolest outside, and hottest at the centre—which I think you will grant—there must be a gradual increase both of temperature and of pressure towards the centre. The observations which have been made during eclipses indicate with sufficient definiteness that there is an undoubted increase of temperature towards the centre, and that the various appearances which we get at the photospheric level really mean that at this point, where the pressure is greater than at any superior level—as the pressure in London is greater than the pressure on the top of Mont Blanc—the temperature also is higher, as is indicated by the extreme brightness of the objects seen, as compared with the dimming off of those parts of the solar atmosphere which are farther removed.

Now, can we watch this? Can we study it so that we can find out all about it? Well, not entirely. The photosphere which carries the spots to which I have referred allows us certainly to see the phenomena of the spots, but then it acts as a veil that prevents us seeing anything nearer the centre of the sun, whatever it is. It practically serves as a veil for all the underlying phenomena. Also, as I have mentioned, the outer corona is only visible for a few minutes in each generation; so that, when we attempt to watch the totality of the phenomena from the top of that magnificent radius down to that part of it which cuts the photosphere, there are difficulties of every kind supervening; we can only continuously and effectively study those regions of the atmosphere just above the photosphere, or in other words the phenomena included in the inner corona.

Absorption of the Sun's Atmosphere

But in addition to this there is something else that we can do, though this work is not so valuable, as its results are too general. We can study the general absorptive effect of the whole atmosphere above the photosphere by dealing with ordinary sunlight reflected from a cloud.

The three kinds of absorption which we recognise in spectrum analysis are these. First of all, we have a selective absorption which enables us to determine the presence of the incandescent vapour of any particular metal in the atmosphere of the sun.

Next it was pointed out in the year 1873[1] that the absorption of some elementary and compound gases is limited to the most refrangible part of the spectrum when the gases are rare, and creeps gradually into the visible violet part, and finally to the red end of the spectrum as the pressure is gradually increased. It looks very much as if all the permanent gases, or all gases and vapours at a temperature below that which enables them to give out bright lines or flutings, really possess this kind of absorption, and we know that the absorption of that kind at the sun is enormous, because the blue spectrum of the electric light is very much longer—six or seven or eight times—than the spectrum of the sun, because we get an ultra-violet radiation from the electric light which has been stopped in the atmosphere of the sun. As there are permanent gases in the sun's atmosphere the same conclusion is good for it also. If this absorption both here and at the sun were taken away, it is clear that the sunlight would be much bluer than it is at present. Prof. Langley, of the United States, who seems to be unaware of the results arrived at in 1873, has recently made the same announcement.

There is one other kind of absorption also. We have a general absorption—an absorption working equally upon all parts of the spectrum, which we may call general absorption in its true sense—such absorption, for instance, as we should get by mixing soot with water or smoking a glass and holding it in front of the sun—this would cause a considerable dimming of the light.

We can make this general examination of the atmosphere of the sun by simply observing the spectrum of sunlight reflected from a cloud; but it will be readily understood that, although in that case we shall be able to study the indications of selective absorption and the absorption of the blue end of the spectrum due to such gases as chlorine, and the general absorption of the spectrum due to the existence of solid particles; it will still be an inquiry which will only deal with the matter in its most general aspect, and we shall not be able to localise the exact regions in which these absorptions take place. Further we may say that the result of this study of the absorption of the solar atmosphere taken as a whole is chemical and statical merely. There is nothing dynamical about it. It tells us most important facts concerning the chemical constitution of the sun's atmosphere, taken as a whole, without localising the region in which any particular substance which we find to be absorbing is absorbing; but it does not tell us whether this atmosphere of the sun, which roughly we may accept as about a million of miles high, is in violent movement, or whether it is at rest.

There is, then, very much more to be done before we are fully in presence of the causes of the phenomena to which I have called attention, which stare us in the face every time we look at the sun, either when it is eclipsed, or when it is not.

J. N. LOCKYER

(*To be continued.*)

[1] *Phil. Trans.*, 1873, vol. clxiv. part 2, p. 491.

SCIENTIFIC SERIALS

THE numbers of the *Journal of Botany* for January and February contain no papers of very great importance. Messrs. H. and J. Groves record the addition of two new species to the British Characeæ: *Chara intermedia* and *Nitella capitata*, with figures of both.—Mr. J. G. Baker attempts to trace the relationship between the British and the Continental forms of the difficult genus *Rubus*.—Another addition to the British flora is recorded in *Equisetum littorale*, by Mr. W. H. Beeby.—Most of the other articles relate to descriptive or geographical botany.

THE most important paper in the *Nuovo Giornale Botanico Italiano* for January is an account by Sig. F. Morini of a new disease of cereal crops caused by the attacks of a hitherto undescribed parasitic fungus, *Sphærella exitialis*, allied to *S. graminicola* and *S. Tassiana*.—Sig. Pichi investigates the nature of the reddish-brown spots on the stem of *Bunias Erucago*, which he finds to come under the head of glandular emergences; and Sig. Cavara describes some singular anomalies and monstrosities in the flowers of *Lonicera*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 14.—"The Coefficient of Viscosity of Air." By Herbert Tomlinson, B.A. Communicated by Prof. G. G. Stokes, P.R.S.

The author employed the torsional vibrations of cylinders and spheres, suspended vertically from a horizontal cylindrical bar, and oscillating in a sufficiently unconfined space. The bar was suspended by a rather fine wire of copper or silver attached to its centre, which, after having been previously subjected to a certain preliminary treatment with a view of reducing the internal molecular friction, was set in vibration.

The coefficient of viscosity of air was obtained from observations of the diminution of the amplitude of vibration, produced by the resistance of the air to the oscillating spheres or cylinders attached to the horizontal bar, arrangements having been made so that the vibration-period of the wire should remain the same, whether the cylinders or spheres were hanging from the bar or not. In deducing the value of the coefficient of viscosity from the logarithmic decrement, the author has availed himself of the mathematical investigations of Prof. G. G. Stokes.[1]

Five sets of experiments were made with hollow cylinders and wooden spheres, in the construction and measurement of which considerable care was taken. When the cylinders were used arrangements were made to eliminate the effect of the friction of the air on their ends. The following are the results:—

Cylinders

Length in centimetres	Diameter in centimetres	Vibration-period in seconds	Temperature of the air in degrees Centigrade	Coefficient of viscosity of the air in C.G.S. units
60·875	2·5636	6·8373	12·02	0·00018171
60·885	0·9636	7·0590	14·63	0·00018122
60·875	2·5636	3·0198	11·69	0·00018024
53·175	2·5636	2·9994	10·64	0·00017845

Spheres

6·364	2·8801	9·35	0·00017820

Maxwell has proved[2] that the coefficient of viscosity of air is independent of the pressure and directly proportional to the absolute temperature. We can, therefore, calculate from the above data what would be the value of the coefficient of viscosity at 0° C.; and when this is done, in the case of each of the five sets of experiments, we obtain the following values:—

Set of experiments	Coefficient of viscosity of air at 0° C.
1st	0·00017404
2nd	0·00017201
3rd	0·00017284
4th	0·00017359
5th	0·00017230

The mean of these numbers is 0·00017296 with a probable

[1] See Prof. Stokes's paper "On the Effect of the Internal Friction of Fluids on the Motion of Pendulums," *Trans.* Camb. Phil. Soc., vol. ix. Part II., 1850.

[2] *Phil. Trans.*, 1866, vol. clvi. Part I.

error of only 0·14 per cent. The formula for finding μ_t, the coefficient of viscosity of air at the temperature $t°$ C., is therefore—

$$\mu_t = 0·00017296 \left(1 + \frac{t}{273}\right).$$

The value of the coefficient of viscosity of air at 0° C., given above, though much nearer to that obtained by Maxwell than any which has been got by other observers, nevertheless differs from it by more than 8 per cent.[1]

January 28.—"On Local Magnetic Disturbance in Islands situated far from a Continent." By Staff-Commander E. W. Creak, R.N., F.R.S.

It has long been known that local magnetic disturbance has been found to exist to a considerable extent at St. Helena, Bermuda, and other islands. Observers in the islands adjacent to the west coast of Scotland have also found local disturbance existing in them, and, in order to determine its amount, have obtained normal values from curves of the magnetic elements calculated from neighbouring regions where observations have been made apparently free from magnetic disturbance.

In the case of islands situated far from a continent, however, normal values of the three magnetic elements may be obtained by the method of turning the ship in azimuth and observing on eight or more equidistant points of the compass in the process called "swinging," whereby the effects of the horizontal disturbing forces proceeding from the iron of the ship may be eliminated, and by occasional observations at well-selected land stations known to be free from local magnetic disturbance, the values of the vertical magnetic forces caused by iron in the ship may also be ascertained for all latitudes, and the necessary corrections applied to the observations.

A series of magnetic observations have been made on land in Bermuda, Madeira, Teneriffe, St. Vincent (Cape de Verde), St. Paul Rocks, and Sandwich Islands in the northern hemisphere and Tristan d'Acunha, Ascension, St. Helena, Kerguelen Island, New Zealand, and Juan Fernandez, in the southern hemisphere. The observations made in these several islands have been collected for this paper and compared with the normal values as observed at sea in their neighbourhood.

Throughout the discussion the term "blue" magnetism has been adopted to indicate that kind of magnetism which attracts the marked or north-seeking end of the needle, and "red" for that which repels it.

At Bermuda the most extensive series of observations has been made, and a strong focus of blue magnetism found to exist between Mount Langton and the lighthouse on Gibbs Hill.

The position of this focus was approximately defined by drawing, on a map of the western portion of Bermuda, lines of equal values of the disturbance from the normal for each element, and it was found that at one position eastward of this focus the westerly declination was increased 2° 39′, and at another, westward of it, diminished by 3° 5′. The disturbance of the inclination and vertical force gradually increases as the focus is approached, amounting in the inclination from +0° 11′ to 1° 47′, and in the vertical force from zero to +·314 (British units).

Bermuda may be taken as an example of the results generally found in the other islands under discussion, for the observations show that, north of the magnetic equator, the north point of the compass is invariably attracted inland towards some part of the island, and south of the magnetic equator it is repelled, showing marked divergence of results between observations made on the east and west coasts. The inclination and vertical force are, with rare exceptions, increased in the islands on both sides of the magnetic equator.

On the whole the local disturbances are not very large, but it may be remarked that they render the comparison of observations at different epochs very doubtful in value, unless the precise position of observation be rigidly adhered to.

Before dismissing the question of the actual observation, the results obtained at the Bluff, Bluff Harbour, New Zealand, are worthy of note—

Declination observed	On the summit of the Bluff ...	6	54	E.
	30 feet north ,, ...	9	36	W.
	,, west ,, ...	5	4	E.
	,, east ,, ...	46	44	E.
Normal from sea observations		16	20	E.

[1] Prof. Stokes, in a note at the end of the paper, has shown that a very small deviation from horizontality of the movable disks used by Maxwell would make the value of the coefficient obtained by him 8 per cent. too great.

On the summit of the Bluff there was thus shown to be a strong focus of red magnetism.

The general results tend to show that the magnetic disturbance in islands north of the magnetic equator is due to an excess of blue magnetism, and in those south of it to an excess of red magnetism compared with that due to the respective positions of the islands on the earth considered as a magnet.

In Sir G. Airy's treatise on magnetism, reasons have been given for believing that the magnetism of the earth is not due to sources external to it, nor specially existing on its surface, but that the source of its magnetism lies deep.

With these reasons in view, and the results obtained from the observations discussed, the possible conclusion is drawn that the excess of "blue" and "red" magnetism observed in the islands above-mentioned proceeds from portions of those islands which have been raised to the earth's surface from the magnetised part of the earth, forming the source of its magnetism.

For the numerical data upon which the preceding remarks have been founded, and descriptive map of the Bermuda magnetic disturbances, reference should be made to the original paper.

Linnean Society, February 4.—Sir John Lubbock, Bart., President, in the chair.—Mr. J. Dallas, of the Exeter Museum, exhibited a specimen of the somewhat rare glossy ibis (*Plegadis falcinellus*, L.), obtained from Mr. J. H. Clyde, of Bradsworthy Vicarage, Holsworthy, Devon, in whose possession it had been since killed in that neighbourhood, September 1851.—Mr. F. J. Hanbury showed a series of forms of the genera Hieracium and Carex gathered by him in Caithness and Sutherlandshire, all new to Britain, but representative of the Scandinavian flora.—Mr. C. Bartlett showed a remarkable African (?) caterpillar, 7 inches long, of a steel-gray colour, and abundantly hairy and spiny.—Mr. W. H. Beeby drew attention to an example of *Equisetum littorale* got by him on Bisley Common, Surrey, and hitherto not known as an English plant.—Mr. J. C. Sawer exhibited a sample of a superior sort of the essential oil of lavender and a spike of the plant, a cross-breed of varieties introduced by him from the Continent, and grown at Brighton.—Mr. A. Hammond showed a microscopic section of the integument of the larva of a dipterous insect (*Stratiomys chamæleon*), raising the question as to whether the polygonal areas of the cuticle, described by M. Villianes, were surface-markings only, or, as he held, cellular in character.—Mr. F. Darwin read a paper on the relation between the bloom of leaves and the distribution of the stomata. "Bloom" on leaves is used by him to mean a coating of minute particles of a waxy character, which is removable by hot water or ether. But gradations occur from a distinct and appreciable greasiness throwing off moisture to such as are easily wetted. A large series of leaves of different groups of plants have been studied by him, and for convenience in the analysis of data he has divided them into four classes. Leaves of Class I. are devoid of bloom on both surfaces, and yield 54 per cent. which have *no* stomata on the upper surface. In Class II. bloom is deficient above but present below, whereof 83 per cent. contain stomata on the leaves' lower surface. Class III. possesses bloom on the leaves above, but none inferiorly, and 100 per cent. of these have stomata on the upper surface. Class IV. have leaves with bloom on both surfaces, 62 per cent. of them having stomata above. From such analyses and other facts and data given, Mr. Darwin concludes that the accumulation of stomata accompanies that of bloom, and, other things being equal, that it is functionally protective against undue wetting by rain, and thus injury to the leaf-tissue.—In a communication by Mr. E. C. Bousfield, on the Annelids Slavina and Ophidonais, he criticises Herr Vejdovsky's new genus *Slavina*, and objects to his identification of *Nais appendiculata* and *N. lurida*, while giving a full description of the latter, and observing points of contrast. He also describes touch organs in Ophidonais, similar to those of Clavina, mentioning other points of similarity between the two. He further proposes to do away with the former genus, including its only species under Slavina.—Brigade-Surgeon E. Bonavio, in a paper afterwards read, asserts that the wild *Citrus hystrix*, D.C., is the grandparent of *Lima tuberosus*, *L. agrestris*, *Limonis feri*, *Limonellus auririus*, and others, while also more distantly the grandparent of the cultivated true limes of India, Ceylon, &c. The reason why the lime has so persistently a winged petiole, according to him, is that this is derivative from the immense winged petiole of its progenitor *Citrus hystrix*.—Prof. Richard J. Anderson communicated a paper on the relative lengths of the segments of limbs in the chick during development between the sixth and twentieth days. On or even before the ninth day, the bones of the fore-arm and manus are longer than the corresponding segments of the leg and foot. Afterwards the tarso-metatarsus begins to lengthen, and maintains a greater relative size at the end of incubation.

Zoological Society, February 16.—Dr. St. George Mivart, F.R.S., Vice President, in the chair.—Mr. Sclater exhibited a specimen of the new Paradise-bird, *Paradisornis rudolphi* of Finsch and Meyer, lately discovered by Mr. Hunstein in the Owen Stanley Mountains of New Guinea, and pointed out the characters in which it differs from typical *Paradisea*.—The Secretary exhibited, on behalf of Mr. Taczanowski, C.M.Z.S., the skin of an owl from the south-east of the Ussuri country, on the frontiers of Corea, which appeared to be referable to *Bubo blakistoni* of Seebohm.—Mr. E. Gerrard, Jun., exhibited heads and skulls of two African rhinoceroses (*R. bicornis* and *R. simus*), obtained by Mr. Selous in Mashuna-land.—Prof. Ray Lankester exhibited and made remarks on a drawing of a restoration of *Archæopteryx*.—Mr. Oldfield Thomas gave an account of a striking instance of cranial variation due to age, as shown in two specimens of the skull of the Canadian marten (*Mustela pennanti*), which presented extreme differences in the breadth of the zygomata, in the contraction of the interorbital space, and in the development of the occipital crest. Special stress was laid on the fact that such changes as these take place after the animal has attained maturity.—Mr. W. L. Sclater exhibited and described a new Madreporarian coral, which he proposed to call *Stephanotrochus moseleyanus*. The coral had been dredged in the Faroe Channel during the cruise of H.M.S. *Triton* in the summer of 1882. Some account of its anatomy and histology was also given.

Chemical Society, February 4.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following note was read:—The chemical formula for wool keratine, by Edmund J. Mills, F.R.S.—A lecture was delivered on methods of bacteriological research from a biologist's point of view, by Dr. Klein, F.R.S. The object of the lecture was to bring before the Chemical Society the methods used at present by pathologists in the investigations of micro-organisms associated with disease. These methods, thanks to the investigations of Koch, are greatly in advance of those hitherto employed by chemists in the investigation of the activity of bacteria. The enormous amount of work that has been done by chemists since the memorable investigations of Pasteur on fermentation and putrefaction, if viewed in the light of modern bacteriological methods, is in a great measure unsatisfactory and imperfect, more so than will be conceded by chemists. This unsatisfactory state is chiefly due to the imperfect methods employed. Specific chemical action is ascribed to certain organisms, because these were found present in the substances examined, no regard being paid as to whether these organisms were alone active or whether they were only concomitant and dependent on the activity of others. Numbers of instances can be adduced to prove this: amongst them may be mentioned the assertions that alcoholic fermentation is produced by *Mucor racemosus*, and also by a bacillus besides saccharomyces; that the ammoniacal fermentation of urine is due to a bacillus; that the lactic acid fermentation is due to a micrococcus and also to a bacillus. To determine whether a definite chemical process is produced by a definite organism, and which, it is necessary to prove (1) that the substances to be acted upon are at the outset free of any accidental organisms; (2) that the particular organism to which the definite chemical activity is ascribed is the only one concerned in this process. The methods used must fulfil these elementary conditions, that is to say: (1) the materials used must be sterile at the outset, and protected from accidental contamination; (2) the specific organism must be obtained in pure cultivations, and this purified organism must be capable of producing the specific chemical change. Viewed in this light, few of the assertions hitherto made bear criticism. As one of the most striking instances it may be mentioned that, notwithstanding the enormous amount of knowledge gained by chemical research into the changes of proteid bodies during putrefaction, there is no reliable answer yet given to the questions—Which organism or organisms are concerned in this complex process? Which part of the process is due to which organism? Is the analytical process by which proteids are carried down to relatively simple nitrogenous principles done by one or more organisms and by which? Is the production of the alkaloids known as ptomaines due to the same organism or organisms which started the process of putrefaction? Another equally important series of investigations refers to the process of nitrification; here also no definite answer can be given. So also the chemical changes due to the growth of moulds are waiting for investigation. When chemical research begins to adopt such methods as are employed by pathologists, but not till then, its results will be unequivocal. The methods used for sterilising materials, for studying and recognising the morphological characters of organisms, for obtaining pure cultivations, and for inoculating nutritive materials with them were then minutely described.

Physical Society, February 13.—Annual General Meeting. Prof. F. Guthrie, President, in the chair.—Prof. T. H. Huxley and Mr. A. E. Mills were elected Members of the Society.—The President read the report of the Council. The Treasurer, Dr. E. Atkinson, presented his report, which was adopted. The meeting resolved that votes of thanks be accorded to the Committee of the Council of Education, the President and Officers of the Society, and the Auditors of the Society's accounts. The meeting then proceeded to elect officers for the forthcoming year, and a ballot having been taken, the following were declared elected:—President: Dr. Balfour Stewart, F.R.S.; Vice-Presidents: Dr. J. H. Gladstone, F.R.S., Prof. G. C. Foster, F.R.S., Prof. W. G. Adams, F.R.S., Sir W. Thomson, F.R.S., Prof. R. B. Clifton, F.R.S., Prof. F. Guthrie, F.R.S. (the above have filled the office of President), Prof. W. E. Ayrton, F.R.S., Shelford Bidwell, M.A., Prof. H. McLeod, F.R.S., Prof. W. Chandler Roberts-Austen, F.R.S.; Secretaries: Prof. A. W. Reinold, F.R.S., and Walter Baily, M.A.; Treasurer: Dr. E. Atkinson; Demonstrator: C. Vernon Boys; other Members of Council: Conrad W. Cooke, Prof. G. Forbes, F.R.S.E., Prof. F. Fuller, R. T. Glazebrook, F.R.S., Dr. J. Hopkinson, F.R.S., Prof. J. Perry, F.R.S., Prof. J. H. Poynting, Prof. A. W. Rücker, F.R.S., Prof. S. P. Thompson, Dr. C. R. Alder Wright, F.R.S.—Prof. Guthrie, in resigning the position of President, thanked his colleagues for the help they had afforded him since he became President of the Society in 1884; he also congratulated the Society upon the highly satisfactory state to which it had attained.—The meeting then resolved itself into an ordinary meeting. In the absence of the President, Prof. Balfour Stewart, the chair was occupied by Prof. G. C. Foster.—The following communications were read:—On experimental error in calorimetrical work, and on delicate calorimetrical thermometers, by Prof. U. S. Pickering. In conducting a great number of determinations of the heat of dissolution of a solid body in water, the author has had an opportunity of detecting the sources of error incident on such work, and by an examination of the results has not only obtained the mean error of a series of observations, but has been able to apportionate this error to its various causes. In the experimental work it was found that the presence of anything but air between the calorimeter and jacket was most injurious; the space should be entirely open, and no cover of any sort should be used. Before reading the thermometers, as pointed out by Berthelot, the top of the stem should be tapped for some time, otherwise the mercury lags behind the true temperature; but besides this thermometric error, which the author calls the "temporary error," is another effect which may be termed the permanent error, of a similar kind, which no amount of tapping will remove. He has found and verified by special experiments that a thermometer when rising is invariably too low, while when falling it is invariably too high. Error due to this, which varies in amount with different instruments, is avoided by conducting the whole experiment with a rising or with a falling thermometer. The thermometers employed in these experiments had a range of 15° C., and a total length of 600 mm. The experiments were performed at temperatures varying from $-1°$ to 26° C., and as it was important that the same thermometer should be used in different experiments, and even advisable to use the same part of the scale of the thermometer, the following expedient was devised: The thermometer was first heated to the highest temperature required in the experiment, and, by the application of a flame to the mercurial column just below the enlarged space at the end of the tube, that part of the mercury above the flame was broken off and driven into the space, where it remained when the thermometer was cooled. By this means the relative value of a scale division was only inappreciably affected, while the absolute value could be obtained from a single comparison with a standard. From an examination of the results obtained, the author concludes that for further accuracy in this kind of work we must look for improvements in the methods employed, the instruments having, he believes, attained to a state as near perfection as possible.—On some new forms of calorimeters, by Prof. W. F. Barrett. These instruments were constructed for the accurate and ready determinations of specific heats, notably those of liquids. In the first form the bulb of a thermometer is blown into the form of a cup of about 4 cubic centimetres capacity, which thus acts as a calorimeter. Into this cup the liquid is dropped directly from a burette, its temperature being observed by a thermometer in the burette, the mouth of which is closed by the end of the bulb of the thermometer, which is ground, and thus acts the part of a stopper, so that, on raising the thermometer, the liquid flows from the burette into the cup. The thermometer itself forms a balance, the horizontal stem acting as the beam is supported by a knife-edge, and a pan is attached to the further end by the addition of weights to which the weight of liquid added can be ascertained. In the second form a simple thermometer with a large bulb is used, the latter dipping into a silver vessel, into which the liquid is introduced as before.—Prof. S. P. Thompson exhibited a glass calorimeter, similar in construction to that of Favre and Silbermann ; water is used instead of mercury, the great density of which renders it unsuitable for use in so large a glass vessel.

Anthropological Institute, February 9.—Mr. Francis Galton, F.R.S., President, in the chair.—The election of Prof. Otio T. Mason, Prof. J. Ranke, Dr. G. Manouvrier, and Prof. J. Kollmann as Honorary Members, and of the Rev. W. Birks, J. G. Blumer, F. H. Collins, J. Spielman, and T. L. Wall, as Ordinary Members, was announced.—The President read a paper on recent designs for anthropometric instruments, and called particular attention to a number of instruments made by the Cambridge Scientific Instrument Company, and exhibited by Mr. Horace Darwin, who afterwards described them and showed the manner in which they are used.—M. Collin, of Paris, exhibited a traveller's box of anthropometric instruments and Topinard's craniophore.—Prof. A. Macalister read a paper on a skull from an ancient burying-ground in Kamchatka ; and Dr. G. Garson read a paper on the cephalic index, in which he proposed a system of nomenclature for international adoption which has already been accepted in principle by several of the leading anthropologists on the Continent.

Royal Meteorological Society, February 17.—Mr. W. Ellis, F.R.A.S., President, in the chair.—Mr. G. Buchanan, Capt. G. H. Leggett, Dr. H. C. Taylor, J.P., and Mr. J. Tolson were elected Fellows of the Society.—The following papers were read :—General remarks on the naming of clouds, by Capt. H. Toynbee, F.R.Met.Soc. The author considers it important to keep to Luke Howard's nomenclature, leaving it to the observers to express by an additional word any peculiarity they notice in a particular cloud.—On the thickness of shower-clouds, by Mr. A. W. Clayden, M.A., F.G.S. From some measurements made by the author during the summer of 1885 he has come to the conclusion that clouds of less than 2000 feet in thickness are not often accompanied by rain ; and, if they are, it is only very gentle, consisting of minute drops. With a thickness of between 2000 and 4000 feet the size of the drops is moderate. As the thickness gets greater, the size of the drops increases, and at the same time their temperature becomes lower, until, when the thickness is upwards of 6000 feet, hail is produced.—On the formation of rain, hail, and snow, by Mr. A. W. Clayden, M.A., F.G.S. The author points out that all observations tend to show that, except under quite abnormal conditions, the temperature of the atmosphere falls as the height above sea-level increases ; and there seems no reason whatever for assuming that the law does not apply to that portion of the atmosphere which forms a cloud. Hence, if a drop were to be formed at or near the upper surface of a cloud, it would fall down into a region saturated with vapour at a temperature above its own. The result will be further condensation, producing a larger drop ; and this process will continue until it leaves the cloud. If its temperature is below the dew-point of the air it falls through, condensation will continue until it reaches the ground. However, it is obvious that this subsequent gain cannot bear any very large proportion to the growth while falling through the saturated cloud, from which the conclusion follows that the size of the drop must increase with the thickness of the cloud. The author suggests that condensation begins on the upper surface of the cloud by the cooling of some of the liquid cloud-particles. If this particle is cold enough it will solidify, and snow will be formed. Should it not be quite cold enough to solidify at once, owing to its minuteness, but remain still below the freezing-point, hail is formed. Finally, if the temperature is not low enough for either snow or hail, rain is produced.—On three years' work by the "chrono-barometer" and "chrono-thermometer," 1882–84, by Mr. W. F. Stanley, F.R.Met.Soc. The chrono-barometer is a clock that counts the oscillations of a pendulum formed by a suspended barometer. The upper chamber of the pendulum is a cylinder of an inch or more in diameter. By change of atmospheric pressure the mercury in the pendulum is displaced from the bottom to the top, and *vice versâ*. The rate of the clock is accelerated or retarded in proportion to the displacemen tof the mercury. The chrono-thermometer is a similar clock to the above, and the pendulum is also a barometer ; but instead of the lower chamber being exposed to pressure, the whole tube is inclosed in a second hermetically-sealed tube containing air. Atmospheric pressure being thus removed, the expansion of the included air by heat alone forces the mercury up into the vacuum-chamber, and alters the period of oscillation of the pendulum.

Victoria (Philosophical) Institute, February 15.—A paper on final cause, by Prof. Dabney, of Texas University, was read.

EDINBURGH

Mathematical Society, February 12.—Dr. R. M. Ferguson, President, in the chair.—Mr. William Harvey communicated several theorems in kinematics with geometrical demonstrations ; and Mr. R. E. Allardice submitted a proof, by Mr. T. Hugh Miller, of Lagrange's theorem.

PARIS

Academy of Sciences, February 15.—M. Jurien de la Gravière, President, in the chair.—Discourses pronounced at the obsequies of M. Jamin, by M. J. Bertrand on behalf of the Academy, and by M. L. Troost in the name of the Faculty of Sciences.—Remarks on the 172 tornadoes recorded in the United States during the year 1884, by M. Faye. From the scientific point of view the author considers that it seems definitely established that there is a definite portion of an area of low pressure within which the conditions for the development of tornadoes is most favourable. The special tornado reporters for the Signal Service are now endeavouring still more accurately to determine this "dangerous octant," as it is called in America. February 19, 1884, is mentioned as memorable in the history of these destructive phenomena. On that day no less than forty-five were recorded in the South-Eastern States, attended with a total loss of 800 lives, 2500 injured, 10,000 houses and buildings destroyed, and from 10,000 to 15,000 people left homeless.—Note on a prophylactic means of protecting the vine by destroying the winter egg of Phylloxera, by M. P. de Lafitte. This plan has now been tried with considerable success during the last three years at three different places in the department of Lot-et-Garonne. The State aid granted for the purpose having long been exhausted, growers have been encouraged by these results to continue the experiments at their own expense.—On the periods of the double integrals, by M. E. Picard.—On the theory of reciprocants, by M. R. Perrin. It is shown that the new forms introduced by Prof. Sylvester into mathematical analysis may be considerably simplified by the employment of a few general theorems here communicated to the Academy.—Note on the polhodie and terpolhodie (continued), by M. A. Mannheim.—Spectroscopic observations on the new star discovered by Mr. Gore in Orion, made at the Nice Observatory by MM. Perrotin and Thollon. This star presents a fine line spectrum stretching far into the violet, the red and especially the green being remarkably brilliant, while the yellow appears relatively dull. This suggested a certain analogy with the spectra of comets, only much more complicated, and the idea was confirmed by subsequent comparative observations made on α Orionis, which shows a characteristic continuous spectrum intersected by dark bands and lines. Notwithstanding the faint yellow bands, the new star would therefore appear to be of the same type as α Orionis.—Note on the deviation of the equipotential lines, and the variation of resistance shown by bismuth in a magnetic field, by M. Leduc.—On the electrolysis of the salts : influence of temperature, of the distance and surface of the electrodes, by M. Adolphe Renard.—Observations in connection with M. A. Millot's note on the "Products of Oxidation of Carbon by the Electrolysis of a Solution of Ammonia," by

MM. A. Bartoli and G. Papasogli. To M. Millot's statement that he failed to find mellic acid and its derivatives in the electrolysed ammoniacal solution, it is pointed out that the failure was doubtless due to the fact that his experiments were not conducted under the same conditions as those of the authors.—Note on a combination of acetic ether and chloride of magnesium, by M. J. Allain le Canu.—On the influence of the acid oxalate of ammonia on the solubility of neutral oxalate, by M. R. Engel.—On the γ-bromo and iodobutyric acids, $XCH_2—(CH_2)_2—CO(OH)$, by M. Louis Henry.—Note on the affinities of the Eocene floras of the West of France with those of North America, by M. Louis Crié. The attention of geologists and botanists is here directed to certain fossil plants occurring in the Eocene sandstones of West France, which present evident affinities to several species of the lignitic group described and figured by M. Leo Lesquereux in his "Contributions to the Fossil Flora of the Western Territories" (Washington, 1878). *Pteris Fyeensis*, Crié, *Lygodium Fyeense*, Crié, *Lygodium Kaulfussii*, Heer, *Asplenium Cenomanense*, Crié, and others are compared respectively with *Pteris pseudopennæformis*, Lesq., *Lygodium Dentoni*, Lesq., *Lygodium neuropteroides*, Lesq., *Gymnogramma Haydenii*, Lesq., &c.—Note on the subject of atmospheric disturbances—M. Faye's theory of whirlwinds, by M. Jean Luvini. It is shown that the slight convergence of the current towards the centre of great cyclones, as appears determined by observation, would be more opposed to the theory of absorption than to M. Faye's gyratory theory. A slight convergence near the ground is in fact a natural consequence of the principles regulating the movement of fluids.

BERLIN

Physiological Society, December 11, 1885.—Dr. Gad spoke of an apparatus executed by him and set up in the demonstrating-room, designed to show the play of the valves of the heart. A short canula of 7 cm. in diameter was tightly fixed into the left auricle of a large bullock's heart, and the free end was closed in a water-tight manner by a plate of looking-glass. At the side of the canula was a short tube connected by an elastic tube with an upright bottle. A similar canula of 3 cm. in diameter was fastened into the aorta close over the semi-lunar valves, and its lateral tube conducted by an elastic pipe into a funnel through which the water flowing from the ventricle reached the bottle. A third canula was fastened into the apex of the heart, and connected with a thick-walled elastic ball, by the compressions and elastic expansions of which the vigorous operations of pressure and expansion required for the circulation of the water filling the apparatus were achieved. In the ventricle was placed a small Edison lamp, the conducting wires to which were, by means of a water-tight tube at the side of the third canula, directed outwards. When the elastic ball was rhythmically compressed, then the alternating play of the cardiac valves was seen through the two first canulæ, and, by means of a suitable mirror before the canulæ, might be exhibited to a large class.—Dr. Goldscheider reported on the results of an investigation into the nerve-endings at the pressure and temperature points, the existence of which he had demonstrated. In the expectation that specific terminal organs of the cutaneous nerves must, if they existed, be met with at the pressure points and points of cold and warmth, Dr. Goldscheider had cut out of his forearm, at the isolated pressure points and temperature points, small wedges of skin, and prepared them with arsenic acid and auric chloride, embedding in paraffin. Of the preparations he made a series of sections which in most cases showed longitudinal sections through the cutaneous nerves. The microscopical examination revealed that no Paccinian or Meissner corpuscles were situated either at the pressure or at the temperature points. On the contrary, the speaker found regularly at the pressure points, which he had previously marked by the prick of a needle, a bundle of medullated nerve-threads approaching close to the boundary of the corium. At this point the bundle split into two branches proceeding in opposite directions, and then further ramifying. These two divisions made their way mostly between the corium and epidermis, and but seldom penetrated as far as the second layer of the epidermis cells. So far as ends of the nerves were visible, they were situated between the cells and were pointed. On the temperature points a bundle of nerve-fibres were likewise seen to rise, but in this latter case they ended in a pretty narrow net of very fine, non-medullated threads, and never reached the epidermis. In the neighbourhood of the nets of the temperature nerves blood-capillaries were regularly met with. Dr. Goldscheider was of opinion that the cutaneous nerves possessed no specific terminal organs, but simply merged into narrower or wider nets, and that the sensitive points for pressure and temperature were situated at the spot where the terminal division of the nerve-bundles occurred.—Dr. Benda supplemented the address he delivered at the last meeting on spermatogenesis by hypothetical considerations regarding the significance of the microscopical figures found by him.

January 15.—Dr. Müllenhoff spoke of his observations respecting the structure of bee-cells. Producing specimens of combs and models, he handled the geometrical figure of the cells, the fact of which had been recognised so far back as the time of the Greek philosopher Pappus, and the measure of which had been taken by Réaumur, the cells forming a hexagonal column bounded on the side turned to the partition wall by a trilateral pyramid, on the other by a plain terminal surface. To account for the great regularity of the cells, Buffon had propounded that they originated in the mutual pressure of the wax-vesicles, and put this explanation to the proof by an experiment in which he filled up a vessel with peas, and stuffed the interstices with water, which caused the peas to swell. In point of fact the round bodies got thereby converted into precisely geometrical figures with trilateral terminal surfaces. They were, however, no hexagonal columns, but regular rhombendodecahedrons. Dr. Müllenhoff had now, by a long series of observations in beehives, studied the structure of the bee-cells, and had established that the bees, which, as was known, worked closely compacted together, first stuck a little thick wax disk to the wall, and then gnawed away at it till the plate had grown so thin that under the all-sided pressure, in accordance with the law respecting equilibrium figures of fluid membranes discovered by Plateau, they assumed the form of a half rhombendodecahedron with trilaterally pyramidal surfaces. The bees then proceeded to build on the six free edges by attaching to them small wax plates, and gnawing away at them till they had grown so thin that under the pressure of the neighbouring cells they took on the form of a hexagonal column. The column was made so long that the queen bee, in laying her eggs, rested with her posterior body on the floor of the cell, and, with her anterior legs, was able to take hold of the free edge of the column. The geometrically-regular figure of the bee-cells was accordingly conditioned by physical laws, and not by any knowledge inherent in the bees of geometrical laws in respect of the greatest economy of space and material. That without the co-operation of the Plateau laws the bees were able to achieve no regular cells was demonstrated by the queen-cells, which, constructed isolatedly, had the irregular form of a thimble.—Prof. du Bois-Reymond gave a short summary view of the investigations he had carried out in the past summer into living torpedoes, by means of which he had pretty well solved all the problems which were at all capable of being submitted to experimental test on the animals of the aquaria, which were very much reduced in strength and exhausted by inanition. Having first ascertained the direction of the cuticular current, he examined the polarisation-phenomena yielded by stripes of the electrical organ under the influence of foreign currents. He learned that homodromous currents, *i.e.* such as were directed in the same way as the direction of the shock, gave always a homodromous polarisation, while heterodromous currents never produced heterodromous polarisation, and only occasionally homodromous polarisation. This fact was capable of explanation by assuming that what appeared as homodromous polarisation was but a shock of the fish caused by the foreign current, a shock which of course could only be homodromous; or that the electrically polar molecules directed by the foreign polarising current were capable of being turned only in one direction. A decision between these two explanations could not be arrived at. Prof. du Bois-Reymond next examined the conductivity of the electrical organ, and ascertained that it conducted homodromous currents almost as well as did the muscle, but that it conducted heterodromous currents much worse, so that the electrical organ was almost half an insulator for heterodromous currents. The conduction power of the electrical organ of the torpedo was consequently irreciprocal. This irreciprocity of conduction obtained only for strong currents and for those of short duration. It was met] with, moreover, only in the living organ. The defunct organ conducted considerably better than the living, and was equally good for the conduction of homodromous and heterodromous currents. The irreciprocity, finally, increased with the length of the organ stripe. This irreciprocity of conduction explained in a most highly interesting manner the powerful effect of the strokes directed outwards of electrical fish. Let us suppose a column of the electrical organ reaching from the back to the belly, then would the electrical currents of the organ diffuse themselves at the positive pole surface of the back, and in accordance with well-known laws respecting the distribution of electrical currents in an endless conductor, betake themselves to the negative pole surface of the belly. Were the organ a good conductor of its currents, then would the most intense threads of currents balance themselves in the organ, and only very faint ramifications of current penetrate into the water. These currents, however, had a heterodromous direction in the organ, and were therefore ill-conducted. The most intense threads of current were forced therefore to penetrate into the water, and were accordingly able to produce vigorous effects outwardly. The speaker had finally examined a phenomenon in the powerful electric nerves of the torpedo, which he had earlier had occasion to observe in other nerves. If a piece of nerve were cut off and the electromotory energy of the two transverse sections determined, then did the electric nerves show that the peripheral cross-section acted in an electromotory sense more powerfully than did the central. If both cross-sections were derived, then was an ascending current received in consequence thereof. This occurred with such regularity that the peripheral and the central nerve could be recognised on any piece whatsoever by the direction of the axial nerve current, which was opposed to the direction of the physiological action. In the sensory nerves Prof. du Bois-Reymond had found a reverse axial current directed from the centre to the periphery. He had the phenomenon then further investigated by Dr. Mendelssohn, and it was quite generally established that centripetal active nerves, such as the nerves of the senses and the posterior roots of the spinal nerves, always showed a descending axial nerve current, whereas centrifugal active nerves, such as the motory and the electric nerves, possessed an ascending axial nerve current. In the case of mixed nerves an axial nerve current could not be decidedly demonstrated.

Meteorological Society, January 12.—Dr. Hellmann laid before the Society in the form of a table, the results of the rain registration at the eleven stations to the west of Berlin for the six months from July to December, and drew attention to the fact that in the winter months the values yielded by the different rain-gauges coincided very closely, whereas in summer differences reaching as much as 50 per cent. occurred.—Herr Opel spoke of the quantities of water discharged by rivers, and in particular by the Elbe. In view of the great difference prevailing in the registrations of the amounts discharged at high water, it deserved to be noted as an indication of important progress that Herr Sasse, on the basis of a careful special investigation of the subject, had formulated the proposition that the curve of the quantities of water discharged formed a parabola to the high-water marks as abscissæ, but that the zero-point of the parabola lay deeper than the zero-point of the water-mark. From a long series of examples the author demonstrated the correctness of the formula, and directed attention to several singularities in the quantities of water discharged by the Elbe at various stations of its course through Germany, singularities which, while in part explicable by the tributaries, demanded further investigation. The speaker then discussed the question of the volumes of water in rivers, on which in quite recent times several scientific investigators had expressed an opinion to the effect that they had diminished in comparison with the volumes of water in the rivers last century. This diminution of volume was in large part attributed to the progress of the denudation of forests in the river districts. Herr Opel was, however, of opinion that these registrations of the rivers were rather related to the present well-ascertained lower state of the rivers at low water. Since at many places the beds of the rivers had, altogether irrespective of their profile, been enormously narrowed, the rivers at high water had, in consequence, dug themselves out a deeper channel, and in this way depressed the mass of waters. Rain returns did not, at all events, testify to any diminution in recent times in the supply of water. The observations on the amounts discharged by the rivers of Prussia have hitherto rested on very unsatisfactory bases. At a number of stations daily observations of water-marks were made. The average of these was then taken, and the monthly and yearly averages of these water-marks were used as a basis for the calculation of the monthly and yearly discharges. Seeing, however, that the amount of water discharged represented a parabola, it was impossible to calculate it from the height of the state of the water alone. The amounts of water corresponding with the average water-marks deviated, as was shown in a number of instances, very considerably from the average of the water volumes corresponding with the several high-water marks. Another source of error lay in the circumstance that the observations of water-marks were made only once a day, from which observations the monthly and yearly averages were deduced. In view, however, of the repeated and often important variations in the states of the water, once-a-day observations were really of little value. Hourly observations even would not suffice. What is required are self-registering gauges of the states of the water, as being the only means whereby to obtain trustworthy values for the amount of the river-discharges. Over and above this, in the case of the larger rivers, measurements of their respective quantities at low, mean, and high water should, every few years, be very carefully made and the parabola determined, from which the quantities discharged could then be calculated from the registered high-water marks with some degree of certainty.

BOOKS AND PAMPHLETS RECEIVED

"Class-Book of Geology": Dr. A. Geikie (Macmillan and Co.).—"Trigonometry for Beginners": Rev. J. B. Lock (Macmillan and Co.).—"Fourth Annual Report of the Board of Control of the New York Agricultural Experiment Station for the Year 1885" (Andrews, Rochester).—"The Co-operative Index to Periodicals," vol. i. No. 4 (New York).—"Hints for Land Transfer and a State Land-Bank": Nemo.—"Revista di Artiglieria e Genio," vol. i. (Roma).—"The Star-Guide": Latimer Clark and Herbert Sadler (Macmillan and Co.).—"The Artist's Manual of Pigments": H. C. Standage (Lockwood and Co.).—"Observaciones Magnéticas y Meteorológicas del Real Colegio de Belen de la Compania de Jesus," January to March, April to June, 1885 (El Iris, Habana).—"Scientific Results of the Second Yarkand Mission—Aranelida": Rev. O. P. Cambridge (Government Printing-Office, Calcutta).—"The Comparative Anatomy of the Pyramid Tract": E. C. Spitzka (Jenkins, New York).—"Science for Nobleness, for Knowledge, and for Use": Sir H. W. Acland (K. Paul and Co.).

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THURSDAY, MARCH 4, 1886

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. G. S. Nares, R.N., F.R.S., and Capt. F. T. Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vols. XI., XII., and XIII. By N. Poléjaeff, M.A., P. Herbert Carpenter, D.Sc., Frank E. Beddard, M.A., Prof. William C. McIntosh, Edgar A. Smith, Dr. E. Selenka, and Prof. G. O. Sars. (Published by Order of Her Majesty's Government, 1885.)

DURING 1885 three new volumes of the Zoological Series of Reports have been published. Of these, Part 32 of Vol. XI., "On the Stalked Crinoidea," by Dr. P. Herbert Carpenter, has already been noticed in our pages (NATURE, vol. xxxi. p. 573). The others we now proceed to notice.

Part 31 is a "Report on the Keratosa," by N. Poléjaeff, M.A., of the University of Odessa. The Keratose sponges do not belong to the deep-sea fauna. It is therefore not to be wondered at that the total number of species collected during the cruise of the *Challenger* should have been only 37. It is, however, a little surprising that of this number 21 should be new. The collection embraced forms belonging to almost all the genera of the Keratine sponges hitherto distinguished, and the specimens were for the most part well preserved.

The Report opens with a chapter on the organisation and classification of the group. The subject of the classification of the group is undeniably a difficult one. In no section of the animal kingdom is there a greater danger of describing individuals instead of genera and species. The student has no palæontological data to refer to; embryological details so far as these are known do not help him much; minute anatomy gives but few distinctive characters, and so he is obliged to depend on general anatomical details. When the author acknowledges, as he freely does, that this is so, one is not surprised to find the writers of the past—Duchassaing and Michelotti, Gray, Hyatt, and Carter—depending for their divisions on the properties of the skeleton; nor does one wonder that in their attempts they so often went astray. The division of the Keratosa into two groups, differentiated by having homo- and heterogeneous skeletal fibres, is characterised as thoroughly artificial. The subject of the presence of filaments is capable of no systematic application (the extremely interesting question of what these filaments are is discussed at length, no definite conclusion being come to; it is strange that they never seem to have been examined by a botanist). The presence of true cells in the walls of the skeletal fibres cannot at present be defined as of systematic value. Dr. Vosmäer's arrangement of a division into families, characterised by the properties of both the skeleton mass and of the soft parts is selected as the best possible for the present.

The history of these families and of the various genera placed therein is written with the greatest care and fairness. In agreeing with Hyatt (1875) that Ceratella and Dehitella of Gray are thoroughly sponge-like forms, and not, as Carter (1873) would have them, "nothing but hydroids or coral-like skeletons," he overlooks the fact that in the *Quarterly Journal of Microscopical Science* for January 1870 it is stated that the Ceratellidæ were undoubtedly a "family of arborescent Keratose sponges." The descriptions of the species are accompanied by ten plates of figures. This able Report concludes with a few pages on the subject of the affinities of the group.

Mr. Herbert Carpenter's "Report on the Crinoidea" forms Part 32, and is followed by a "Report on the Isopoda" (part 1), by Mr. Frank E. Beddard, forming Part 33 of the series. This portion of Mr. Beddard's Report relates to the genus Serolis, which occupies a foremost place among the Isopods collected. Of the 16 species collected nine are new. A discussion of the systematic position of the genus within the order Isopoda is postponed until the next Part of the Report, but with regard to the alleged affinity of the genus and of the Isopods generally to the extinct Trilobites, as insisted on by A. Milne-Edwards, the author has nothing to add to what has already been said; the examination of the species found during the *Challenger* Expedition having brought to light no facts which tend to show any close resemblance between the two groups. Of the 22 known species all but four are found at a depth of from 5 to 150 fathoms. Of the four deep-sea forms one is found at a depth of 675 fathoms, a second at depths between 400 and 1600 fathoms, a third between 400 and 1975 fathoms, and a fourth at depths of 600 and 2040 fathoms. In the two species from the latter depth the genus attains to its greatest size. It has evidently had its origin in the Southern Hemisphere, probably around the shores of the south polar continent. While the great majority of the species live in shallow water, the deep-sea forms are in all cases strongly marked; they also show certain peculiarities, notably in the structures of their eyes, which are often absent, but, when present, show great evidence of functional degeneration; indeed none of the deep-sea species possess well-developed eyes. The eye-structure of some of the species is given in great detail and is well illustrated on Plates IX. and X. Ten plates accompany this memoir.

Part 34 of the Zoological Series forms Vol. XII., a portly volume of over 550 pages illustrated by 93 plates. This valuable Report is by Prof. William C. McIntosh. It is on the Annelida Polychæta, and marks quite an era in the history of this group. In a short notice it is impossible to do justice to this laborious work, and we must content ourselves with briefly marking our admiration of the care and research that have been bestowed upon it. Of the species collected no less than 220 are described as new. It is noteworthy that the formation of no new family was required; all the forms fall into groups already constituted, and which have been so satisfactorily diagnosed by Malmgren that the diagnoses have not here been repeated, but a most useful synopsis of the families, genera, and species described is appended to the Report, with references both to the pages and plates. In many cases the food of the Annelids has been examined, and in the case of abyssal forms, it throws some light on the food-resources of the great depths of the oceans. In the North Atlantic Region a large number of forms occur, and relatively few range to other areas, but this apparent distinctness in so vast a region is probably due to the comparatively unexplored condition both of it and the other oceans. Most of the genera are cosmopolitan in their range, but the remarkable new genus Buskiella is entirely confined to the abysses (2025 fathoms) of this and the South Atlantic. In the South Atlantic Region the two chief centres for specimens were the coast of Brazil and the Cape. In the South Indian Region one of the most striking features was the large proportion of species pertaining to Kerguelen. The abundance of Annelids in the deep water of the land-locked bays of this island was remarkable, and many new forms are described therefrom. In the Australian Region the types found were in many cases peculiar and novel; here the branched Syllis, one of the most remarkable discoveries of the Expedition, was found. In the Japanese Region a series of remarkable types were found, while comparatively few came from the North Pacific, and the majority of the specimens from the South Pacific came from the confined waters of the Straits of Magellan.

In regard to bathymetrical distribution, the greatest number of species occurred in the shallow water, 10 fathoms and under. The two regions ranging from 10 to 50 and from 50 to 100 fathoms have each about the same number of Annelids, and both are similar in respect to new forms. In the depth between 100 and 200 fathoms the number was less, but the proportion of new forms was much higher; while in depths between 200 and 500 fathoms almost all the forms were new, and many belonged to new and remarkable genera; between 500 and 600 fathoms the number fell to less than half that in the previous group, but the majority were new. The number found between 600 and 1000 fathoms include two known species out of a list of 14. The four species occurring between 1000 and 1200 fathoms are new. Those species found between 1200 and 1500 fathoms are more than five times as numerous as the last, and include only five known forms, most of which, however, are found in shallow water as well as at this great depth; between 1500 and 2000 fathoms all the species were new. The same is true of those between 2000 and 2500 fathoms; while in the lowest depths, between 2500 and 3000 fathoms several known forms occurred. The majority of the deep-sea forms are tube-dwellers.

Vol. XIII. opens with Part 35, Mr. Edgar A. Smith's "Report on the Lamellibranchiata." On the return of the Expedition all the Mollusca were placed in the hands of the Rev. R. Boog Watson for description, but after separating out the different species, and labelling the greater part of the known forms, Mr. Watson, seeing the immense extent of the collection, determined to limit his descriptive work to the Gasteropoda and Schaphopoda, and Mr. Edgar A. Smith then consented to prepare the "Report on the Bivalves." The author apologises for not using the name Pelecypoda for this group, urging that it has not only priority but also is more in conformity with the names in use for the other classes. When in 1824 De Blainville first used the term Lamellibranchs, though it is true the class for which it was used was not characterised, still the genera placed under it were so well-known, that the name itself may be said to carry its own explanation, and this might fairly secure the priority for a well-known and almost universally accepted name, which in part by accident it would seem is used in this important Report.

In many respects the collection of Lamellibranchs was disappointing. Only some 500 species were obtained, and of these five were represented by a long series of specimens, and in many cases the species were represented by only detached or single valves. When great depths were reached some of the forms found were of particular interest, but it is a remarkable fact that only one distinctly new generic type was discovered. The greatest depth at which Lamellibranchs were found was in the mid North Pacific Ocean at 2900 fathoms, but two species, *Semele* (*Abra*) *profundorum*, n.sp., and *Callocardia pacifica*, n.sp., were found. Some of the species are noted as found not only at widely distant localities but also at very different depths. The Lamellibranch fauna of the deepest parts of the Atlantic and Pacific Oceans is not of a very extraordinary and certainly not of a special character, and it would appear clear that the deeper the dredgings the fewer the species found. The memoir is illustrated by 25 plates, executed in a very creditable manner by the Cambridge Scientific Instrument Company.

Part 36 is a "Report on the Gephyrea," by Dr. E. Selenka, the well-known Professor of Zoology in the University of Erlangen. The number of species (28) collected was small, and they belonged to known genera; 10 were undescribed. The habitat and distribution of some are of special interest; forms previously known as littoral have been dredged from great depths; it would appear probable that the tube-inhabiting Gephyrea occur especially at the greater depths, where as yet has been found only a single example of the free-living forms. Four plates illustrate this Report, on one of which the strange male of *Bonellia viridis* is figured, with its till now overlooked curious segmental organs.

Part 37 is a "Report on the Schizopoda," by Prof. G. O. Sars, of Copenhagen. The collection made turned out extremely rich and of very special interest, containing several most remarkable new types, and greatly increasing our knowledge of the morphology and affinities of the group. In an introductory note the subject of terminology is dwelt on; in a note on the morphology of the group the author decides for the present to "assign to this group the rank of a distinct tribe or sub-order of Decapoda." This sub-order occupies as it were the most primitive position within the division of the Podophthalmia, containing apparently the least modified forms, in which the original characters distinguishing the progenitors of the whole division would seem to exhibit least change.

In an appendix to the Report some interesting details are given of some ecto- and endo-parasites found in the Schizopods; 38 plates, drawn by the author with the aid of the camera lucida, represent all the new species; the drawings are very highly finished, and have been clearly and beautifully printed. It may be noted that the new genera and species described in the Report were briefly characterised by the author in the *Transactions* of the Christiania Scientific Society for 1883.

We have pleasure in again noticing that these splendid contributions to zoological knowledge have been edited and seen through the press with wonderful expedition and accuracy by Mr. John Murray, whose labours as Editor now seem coming to a close.

THE GERMAN NAVAL OBSERVATORY

Aus dem Archiv der Deutschen Seewarte. VI. Jahrgang, 1883. Herausgegeben von der Direcktion der Seewarte. (Hamburg, 1885.)

THIS, the sixth yearly report of the German Naval Observatory at Hamburg, of which Dr. Neumayer is the Director, contains much valuable information as to the increasing and successful application of scientific methods and results to the safe navigation of the German Imperial and Mercantile Navies, in addition to the usual details as to the *personnel* and working of the whole establishment.

The volume contains four papers, but the first is that in which the most general interest is likely to be taken, the other three referring to special reports on subjects connected with one or other of the four departments into which the work of the Observatory is divided.

Commencing therefore with the first paper, there will be found a general report showing much activity in the collating and distribution of information on the important subjects of meteorology, magnetism, and geography, and describing the arrangements for making the observations in the head Observatory at Hamburg, and the affiliated stations on the coast. It may also be noticed that one of the principal additions to the Observatory in 1883 was an instrument for the systematic observation of refraction, but the description is deferred to another report.

Following the general report is an account of the work accomplished in each of the four departments before mentioned.

Department I. is devoted principally to maritime meteorology, and it will be found that the system adopted ollows closely on the lines of our own Meteorological Office in the collection of observations on the coast and at sea, and publication of results.

In Department II. the work resembles in some particulars that which is now making Kew Observatory such a valuable aid to the nautical world in the testing of sextants, barometers, and thermometers. At the Hamburg Observatory, however, they also prove compasses, compensating magnets, log-glasses, and position lanterns for ships' use.

It may be remarked in passing that the production of a novel form of compass by Sir William Thomson in 1876, and the full explanation by him of the principles involved in its construction in several lectures, accompanied by the subsequent success of that instrument in its later form, has had a world-wide influence in modifying the previously conceived ideas of the best form of compass for navigational purposes. For example, at p. 32 of the first paper there will be found the announcement of a new compass constructed in 1882 under the supervision of the Director of the Observatory in which all the principles of the Thomson compass have been carefully retained, but with certain changes securing greater strength in the compass card. These changes were introduced in view of the consideration that the Thomson card was too fragile to stand the rough handling it might be subjected to on board ship. This new compass has been patented in Germany, and after considerable trial in their mercantile marine has proved successful.

But this department has also turned its attention to the instruction of officers in the magnetism of iron ships by approved teachers of navigation, and at pp. 32 and 33 information is given as to the number of ships swung for deviation of the compass by the officials of the Observatory, and their compass arrangements scientifically treated, also of the large number of ships' compass journals sent to the Observatory for discussion. When the journals have been examined, instructions for the future guidance of the captains of the several ships are given as to the probable deviations of their compasses in the ensuing voyage.

As a useful aid to this scientific examination of ship's compasses, the terrestrial magnetic elements with the annual change are given for certain ports on the German coast.

In Department III. the important work relating to weather forecasts, coast meteorology, and storm warnings is carried on, and tables are given showing the number of days on which forecasts were given for inland and the coast, and of the degree of accuracy attained.

In 1883 the first attempt in establishing a limited night service for issuing storm warnings at night was commenced, a lantern showing a red light being hoisted as the signal.

Department IV. conducts all matters relating to the trial of chronometers, and an account is given of the trial of several descriptions of those valuable instruments, as well as of an apparatus for simulating the action of a ship in a seaway upon them, the effect of temperature being observed at the same time.

Six chronometers of the German Navy have been tried in this apparatus, but the results are not reported. It may be a matter of curiosity to hear how far this apparatus has been a success, but long and varied experience in England has shown that if the rate of a chronometer due to the elements of time and temperature are properly ascertained and furnished to the seaman, he will soon find out the effects of the ever-varying motion of his ship at sea with a precision which an apparatus on shore is not likely to attain in advance.

At p. 43 some useful information is given respecting the scientific work carried on independently by the several departments of the Observatory.

Paper No. 2.—This has been written as a guide for popular instruction in the nature of the deviations of the compass in iron ships by means of a model. A woodcut of the model is given, and the results of some twenty-seven experiments recorded. Models of a similar kind are in use in England and America, and are found very useful in imparting practical information concerning the causes and correction of the deviations of ships' compasses.

In Paper No. 3 there is a discussion of a series of observations of the magnetic declination in Barth, made during the years 1881-2-3-4, a period of time which should render them interesting to magneticians.

The fourth and last paper consists of a special report on the trials of marine chronometers sent in by different makers, and of varied construction, during the three years 1880-83. The results of these trials are here mathematically discussed, and chiefly by the use of M. Villarceau's formula for rate, in which the rate g of a chronometer is considered to be a function of the two independent variables—t, the time, and θ, the temperature. The tables of rates recorded resemble very closely those published by the Greenwich Observatory, with the exceptions that, instead of weekly sums of the rates being given, the sums are given for every ten days, and the Centigrade thermometer is used. The chronometers are also kept in a constant temperature for each ten days of the period of trial, commencing with 15° C., then with the temperature raised 5° for each decade until the maximum, 30°, is reached. The trials are continued in the same manner with decreasing temperatures until 5° is reached, and lastly with temperatures increasing to 30° as before.

From what has been said it will be seen that at the Naval Observatory in Hamburg a wide range of subjects is taken under its supervision, and it may be added that the volume now under review is a full and able exponent of its work and aims.

VARIATION IN DOMESTICATED ANIMALS

Fancy Pigeons. By J. G. Lyell.
Poultry for Prizes and Profit. By J. Long.
Book of the Goat. By H. Holmes Pegler.
British Cage-Birds. By R. L. Wallace. (London: L. Upcott Gill, 1885.)

WE have grouped the above-named works together inasmuch as they all treat of the varieties existing in domesticated animals, and are moreover serials in course of publication by the same publisher.

Previous to the issue of Darwin's great work on "Variation in Plants and Animals," the subject was treated with undisguised contempt by biologists generally, and thought to be worthy of consideration only by florists and fanciers, not even its importance in reference to the food supply of man being properly estimated. The origin of this opinion was no doubt correctly given by the late Dr. Gray, when, in reply to the question put to him by the writer of this notice, "Why naturalists ignored the existence of varieties, a variation, however abnormal or monstrous it might appear, being as real as the most normal species," he answered, "The reason, my dear sir, is that they know nothing at all about them."

Nor is this ignorance extinct at the present day. In the Museum of the College of Surgeons may be seen the skull of a crested fowl, with the peculiar bony growth supporting the crest, and the accompanying hour-glass-shaped cavity of the cranium, which are characteristic of the entire race, described as the result of disease in the catalogue compiled by Sir Richard Owen. Nor need we go further than our own unrivalled zoological vivarium to see specimens which every breeder of domestic animals believes to be mere varieties, such as woolly cheetahs and black-shouldered peacocks, exhibited as "good species."

How many naturalists even now care to ascertain what are the limits of variation in any given species, or to what extent the characteristics of allied animals or groups of animals may be reproduced by what Darwin termed "analogous variation."

By careful selection, aided by great practical experience, the skilled breeder can produce almost any pattern of plumage or any disposition of colour he pleases, limited only by the range of colours and markings natural to other animals of the family to which the species belongs on which he is experimenting Thus all the markings of the wild Felidæ can be reproduced in the domestic cat; those of the Columbidæ in the pigeon; but the feline markings cannot be produced in the dog, nor the distribution of colour seen in the Australian pigeons be implanted in the domestic fowl.

It unfortunately happens that the peculiar bent of mind which makes a man a "good fancier" does not necessarily tend to constitute a good naturalist, and it is rare for the two pursuits to be combined in the same person; the zoologist despising the fancier and his monstrosities, which are the result of artificial selection, and the fancier, on the other hand, if he has even a slight acquaintance with zoology, laughing at the naturalist who manufactures what he calls "good species" out of a slight variation of plumage, which he, the fancier, would breed to order without the slightest difficulty. For examples of this proceeding, we need only turn to recently manufactured species of the genus Phasianus.

To those ornithologists who would wish to note the almost infinite variety of pattern, colouration, and marking to which the descendants of *Columba livia* can be bred, we would recommend the "Fancy Pigeons" of Mr. Lyell; it contains a more detailed and fuller account of the numerous breeds than any book in the language, although some of the theories of the writer will not meet with the support of ornithologists. The work, moreover, has a sufficient number of engravings, both coloured and plain, to render the descriptions easy to follow; and these are not, as is too often the case in works written by a fancier for fanciers, grossly exaggerated.

"Poultry for Prizes and Profit" treats, as far as it has proceeded, of the characteristics of the various breeds of fowls, of which, as of pigeons, new varieties are being constantly produced. Of the manner in which fanciers confound species and varieties a strong example is given, the author describing the very distinct and strongly characterised species, *Gallus furcatus*, as a variety of the domestic fowl.

The "Book of the Goat" contains a very good description of the various breeds of goats found in different parts of the world, and most valuable and practical directions for the management of the animal in a domestic state as a useful milk-producer.

"British Cage-Birds," the last of the serials on our list, deals more with wild species than with varieties. It gives the mode of capture, treatment in captivity, &c., of British birds that are kept in confinement for the sake of their song or beauty of plumage. This work is also largely illustrated, but the engravings in many instances are capable of improvement.

W. B. TEGETMEIER

OUR BOOK SHELF

Differential and Integral Calculus, with Applications. By A. G. Greenhill, M.A. Pp. xi. and 272. (London: Macmillan and Co., 1886.)

WITHIN the limits of 267 pages it is not easy to make improvement in so vast a subject as that of this treatise. The chief novelty is the concurrent treatment of differential and integral calculus. A great step in perspicuity has been made by the use of the *complete* notation of hyperbolic trigonometry (sinh, cosh, &c., and $\sinh^{-1}$, $\cosh^{-1}$, &c.), which shows the perfect analogy of the circular and hyperbolic functions in both differentiation and integration. The gain is for mathematicians; its use to practical men may be doubted, as the numerical calculation of these functions is (at present) best done by the familiar logarithms. In the older treatises the applications were chiefly algebraic and geometric; the author's system is to introduce the student at once to a wide scope of applications in both geometry and physics, including some of the higher branches (*e.g.* central orbits, harmonic vibration, Fourrier's and Green's theorems, &c.). It is clear that the account of each must be very brief. In some cases (*e.g.* the article on "Curve-Tracing," Art. 127) it amounts to merely a sketch of procedure and results with scarcely any proof. In an "introductory" work this seems a defect. It is, however, a masterly introduction to the subject, and the wide scope of the applications is well fitted to interest the student.

It remains to notice some defects (in our judgment). About ten pages are devoted to *ordinary* trigonometric relations and tables of mere trigonometric formulæ. This seems too much space (being 4 per cent. of the whole) to such elements. No definition is given of a maximum or minimum, and the treatment of maxima and minima is made to depend wholly on geometry.

On p. 189 it is stated that Taylor's theorem is one "by means of which any function whatever can be expanded" —an obvious slip, corrected lower down (pp. 193, 201). The necessity for the subject-functions, and in many cases also their differential coefficients, being continuous and generally also finite within the limits of any question is not stated. This is, unfortunately, a not uncommon omission in elementary works. ALLAN CUNNINGHAM

Elementary Algebra. By Charles Smith, M.A., Fellow and Tutor of Sidney Sussex College, Cambridge. (London: Macmillan and Co., 1886.)

IT is a pleasure to come across an algebra-book which has manifestly not been written in order merely to prepare students to pass an examination. Not that we think Mr. Smith's book unsuitable for this purpose; indeed, with its carefully-worked examples, graduated sets of exercises, and regularly-recurring miscellaneous examination-papers, it compares favourably with the most approved "grinders'" books. The real want of the present day is a text-book logically arranged and logically written. Apparently no author cares to risk the chance of the financial ruin of his book by going thoroughly to the root of the evil. A policy of "safety" is the most we can expect. This is Mr. Smith's policy, and although we think he might have made fewer concessions to custom and yet have been safe, we welcome his effort very cordially, trusting that, when his book has gained the success which it well deserves, he will see his way to introduce further improvements. He shows to great advantage as a teacher, his style of exposition being most lucid: the average student ought to find the book easy and pleasant reading. The second set of exercises on the binomial theorem is worth specially noting; in many other mathematical books the sets of exercises proposed to the student might well be, as in this instance, *collections of really useful theorems.*

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Pleomorphism of the Schizophyta

SOME students of natural history are content, when the explanations of phenomena which they have advanced and the arguments by which they have supported those explanations are appropriated by other observers, to remain silent, trusting to the justice of future generations for the vindication of their claims. So far as my own experience goes, an active observer who should trouble himself to obtain honest treatment from all his contemporaries in regard to the significance of his published writings, might abundantly employ the latter half of his life in struggling with new writers for that just recognition of his efforts in earlier years in advancing the knowledge of this or that subject, which is the one reward desired above all others by most men who have not attained to the heights of philosophic contempt for the regard and sympathy of fellow-labourers. I do not intend to largely employ my leisure in this pursuit, but there is one subject on which I am anxious once for all to establish the significance of my observations and reasonings published twelve years ago in relation to similar views advanced and accepted at this moment.

That subject is what is now spoken of as the pleomorphism of the Schizophyta or Bacteria.

The view that the genera then recently established by Cohn, viz. Micrococcus, Bacterium, Bacillus, Vibrio, Spirillum, and Leptothrix, are form-phases, or variations of growth of a number of "Protean" species of Bacteria, each of which may exhibit, according to undetermined conditions, all or some of these forms, was definitely and precisely formulated by me in my memoir on "A Peach-coloured Bacterium," published in the *Quart. Journ. of Microscop. Science* in 1873. I distinctly recognised the existence of true species of Bacteria or Schizophyta, but I pointed out that these must be characterised, not by the simple form-features used by Cohn, but by the *ensemble* of their morphological and physiological properties as exhibited in their complete life-histories. I illustrated my conception of the Protean or pleomorphic character of Bacterian species by a reference to the similar character of the species of Calcareous Sponges, and I had in my mind also the closely parallel facts established by Carpenter in relation to the endless variety of forms of the Protozoic Foraminifera.

My view was no merely speculative suggestion, but was based upon a careful study of a remarkable peach-coloured Bacterium, which exhibited a wide range of forms, connected by intermediate forms, growing together in the same vessel, and linked to one another most unmistakably by the fact that they all were coloured by a special pigment which I studied with the spectroscope, and to which I gave the name "Bacterio-purpurin." I observed this organism on many different occasions from various localities; I figured and described its various form-phases; I obtained some modifications of form by cultivation, but chiefly depended upon the association of the different forms, the presence of completely transitional forms, and the common bond of the pigment, for the view as to their nature which I put forward. I gave the name *Bacterium rubescens* to this pleomorphic, or, as I termed it, "Protean," species. I gave an account of further observations on this organism in the *Quart. Journ. Mic. Sci.*, 1876, pp. 27-40.

Cohn opposed my view as to the genetic connection of the various forms associated by me under this name, and, contrary to the established laws of nomenclature, substituted a manuscript name in one of Rabenhorst's collections (viz. "*roseo-persicina*"), for the duly-published name applied by me to this organism. He further described some of its form-phases, already figured by me, as *Monas okeni*, *Monas vinosa*, and *Rhabdomonas warmingii*.

On the other hand, two years later, Dr. Warming of Copenhagen (*Vidensk. Meddelelser. naturhist. For. i. Kjöbenhavn*, 1875), after studying the same organism and figuring many of its form-phases, adopted my view as to their nature, and the extension of that view to the Schizophyta generally. He says: "Les bactéries sont douées en réalité d'une plasticité illimitée, et je crois qu'il faudra renoncer au système de M. Cohn." In 1883 Dr. Neelsen, in his "Studien über die blaue Milch" (Cohn's *Beiträge*, vol. iii. p. 241) cites my views and their confirmation by Warming, and rightly contrasts them with the later views of Nägeli and Billroth, and with that of Lister, who conceived that certain Bacteria were developed from a filamentous fungus (*Dematium fuscisporum*). As the result of his investigation of the *Bacterium cyanogenum* of blue milk, Neelsen says: "Viel eher würde für unsern Fall der Ausspruch Lankesters zutreffend erscheinen, von dem Proteus-ähnlichen Organismus, dessen einzelne Erscheinungs-formen eine Serie von Adaptationen vorstellen."

In 1884 Prof. de Bary of Strasburg, in his "Vergleichende

Morphologie der Pilze," p. 511, says, in regard to the question of species among the different forms of Bacteria:—"There exist two views on this subject which are, at any rate in appearance, totally opposed to one another. The first is, as I think erroneously, ascribed to Cohn. . . . Cohn distinguishes merely what we have above spoken of as form genera and form-species. The other view in its most extreme form amounts to this, that all distinction of species among the Bacteria is denied, and all forms are regarded as modifications of a single species or whatever else it may be called, and these modifications can be transformed by cultivation into one another reciprocally. This view was (if we leave out of consideration older intimations of a similar nature) set up in opposition to Cohn's classification by Lankester in 1873, and by Lister; and in 1874 carried to such a length by Billroth, that he united all the forms of Schizomycetes known to him under one collective species, his *Coccobacteria septica*. It received later a support through the views which Nägeli (1877) expressed in the words, 'I have investigated during the past ten years many thousands of Bacterian forms, and I could not maintain (if I except Sarcina) that there was any need for a separation into even two specific forms.' Nägeli, however, adds that he by no means maintains that all forms belong to one single species: it were a bold thing in his opinion to express a definite conclusion in a matter in which morphological observation and physiological experiment leave the investigator so much in the lurch. He expresses himself again in the same sense in 1882. He nevertheless is, when carefully considered, in agreement with Cohn's fundamental conception, since Cohn erected his form-genera and his form-species (the latter based on physiological properties) primarily in order to gain a provisional survey, and irrespective of the question (as he distinctly states) as to whether as thus distinguished they correspond to natural species.

"Nägeli's words above-cited contain a pregnant criticism of the whole controversy, so far as it had then gone. Both parties failed to bring forward (as is especially the case in Billroth's book) the only certain basis for their opinions, namely, the strict observation of the continuity or the non-continuity of the forms or species in question. In the absence of this, our judgment could only remain suspended, more especially since the forms in question are minute, very like to one another, often mixed together, and consequently easily to be mistaken for one another in the absence of quite strict observation. Lankester certainly came somewhat nearer towards establishing a special case of strictly-observed continuity, since the forms of his *Bacterium rubescens* (*Beggiatoa roseo-persicina*) gave evidence of their connection with one another more clearly by their characteristic coloration. Strictly-made morphological and developmental researches are now to hand. They have demonstrated that the forms known as Cocci, Rods, Threads, &c., are phases of growth (*Wachsformen*)."

Thus writes Prof. de Bary in 1884. To some extent I have reason to thank him for the recognition which he gives to my position in this matter. But I cannot think that he has given a correct statement of my relation to the conclusion which he finally adopts when he associates me with Lister, who derived Bacteria from Fungi, with Billroth, who massed all Bacteria under one collective species, and with Nägeli, who declared that he did not see grounds for distinguishing as many as two.

The view which I put forward in 1873 is *precisely* that which Prof. de Bary now espouses, and I think I may very rightly object to its being confounded with the extreme and exploded theories of other naturalists. As to the "strict morphological and developmental researches" which now have made my doctrine of the pleomorphism of the Schizophytes acceptable to Prof. de Bary, I beg to point out that they do not differ in *character* from my own researches on *Bacterium rubescens*. Prof. de Bary very properly cites the later researches of Cienkowski, Neelsen, Hansen, and Zopf as the chief amongst those which have tended to establish that view as to the forms and species of Schizophyta which I promulgated in 1873. They have done so, *not* by affording us any stricter evidence of actual observation of change of form taking place under the observer's eye, but by multiplying cases similar (in regard to the kind of observation made) to that published by me in 1873, viz. observations of the juxtaposition and structural continuity of different forms, and of the co-existence with extremely divergent forms of abundant intermediate forms.

In relation to the attitude taken up by one of the above-named observers, I have something further to say. Dr. Zopf has made valuable researches on various Bacteria and on the Mycetozoa, and has published the best systematic account of each of these groups which has appeared. In his quarto memoir (Leipzig, 1882) on the Schizophyta, as well as in the smaller hand-book which he has since produced, Zopf gives a reference to my memoir on "A Peach-coloured Bacterium." He has himself repeated my observations on that organism, but he has entirely abstained from pointing out in the text of his work how far his observations are simply repetitions of those published eleven years previously by me (which they are almost entirely), and he has in the most exact details adopted the view as to the pleomorphism of Bacteria which I then put forward, and on precisely the same grounds, without stating that he had been anticipated by me in this respect.

Not only this, but Zopf actually goes out of his way to ascribe to me a view differing from his own, and one which I have never suggested. Either Zopf is writing about my views without having troubled himself to ascertain what they are, or he is purposely misrepresenting them, when he says ("Morphologie der Spaltpflanzen," 1882, p. v.): "Die Annahme Billroth's und Lankester's dass alle Spaltpilzformen nur Einer einzigen naturhistorischen Art oder Gattung zugehören, lässt sich nicht aufrecht erhalten."

I think Dr. Zopf will find it difficult to bring forward a citation from any writing of mine in which I have hinted, even in the remotest way, that "all the forms of Schizophyta belong to a single natural species." Billroth's declaration on this subject was published a year after my statement of the pleomorphic nature of the numerous natural species of Schizophyta, and never appeared to me to have any foundation in a general botanical experience, but to be the result of the restricted observations of a pathologist.

To remove all possibility of further misapprehension, I may be allowed to quote my own words ("A Peach-coloured Bacterium," *Quart. Journ. Mic. Sci.*, 1873, p. 410):—

"The series of forms which I have found in the growth of *Bacterium rubescens* leads me to suppose that the natural species of these plants *are* within proper limits 'Protean.' . . . The natural species among the Calcispongiæ have been shown by Haekel not to correspond at all with the series of *forms* distinguished by his predecessors. . . . It seems exceedingly probable that the same manner of regarding the Bacteria will have to be adopted, Cohn's tribes and genera taking the position of an artificial or formal system, whilst the natural species must be based upon some of those more profound characteristics which Cohn has himself indicated to us in his divisions—saprogenous, chromogenous, pathogenous. The indications of natural species do not lie under our hands in the case of the Bacteria, but have yet to be sought out."

I have now, I think, sufficiently pointed out the position of my publication on *Bacterium rubescens* in the history of the modern doctrine of the pleomorphism of the Bacteria. It will accordingly be readily understood that I cannot contentedly see this doctrine referred to, as it was recently in your columns by my friend Dr. Klein, as "Nägeli's theory of the pleomorphism of the Schizophyta," since Nägeli's view was announced four years after my publication, and is not identical with that at present accepted by De Bary, Zopf, and others, which is, in fact, *precisely* that put forward by me in 1873.

Equally objectionable as falsifying the history of knowledge by assigning to one individual the property of another is a statement in your review of Mr. Crookshank's's "Practical Bacteriology" (NATURE, February 18. p. 361). The reviewer quotes and apparently indorses a statement by Mr. Crookshank, whose book I may observe, though useful in many ways, is wanting in accuracy and in references to original sources. The passage to which I allude is as follows:—"'Researches,' writes our author," "by competent observers have quite recently clearly de-" "monstrated that several micro-organisms in their life-cycle" "exhibit successively the shapes characteristic of the orders" "of Cohn. This had as early as 1873 been observed by" "Lister in a Bacterium in milk. Lister detected forms of" "Cocci, Bacteria, Bacilli, and Streptothrix genetically con-" "nected.' Recent observers also have obtained similar" "results, so that the very foundation of Cohn's classifica-" "tion has been shaken, and we are left without possessing" "a sound basis for classification into genera or species." In the original work of Mr. Crookshank (p. 110) I find the names of Cienkowski, Neelsen, Zopf, Van Tieghem, and others of my successors in this field cited, but no reference is made to the memoir published by me in 1873. Lister's observations led him to quite different conclusions, which he has since abandoned. I am sure that those who are at present busy in this country with the study of Bacteria, and who undertake to write hand-books of the subject, can have no desire to do otherwise than give a just statement of the history of knowledge of the organisms of which they treat. Hence it is with no unfriendly feeling that I offer to Mr. Crookshank and other writers similarly engaged the statement contained in this letter.

February 20 E. RAY LANKESTER

Notes on the Volcanic Phenomena of Central Madagascar

MADAGASCAR is as yet almost a *terra incognita* to the geologist; nothing, so far as I am aware, but notices of the most vague and fragmentary kind ever having appeared in regard to its geological features. Nor indeed may we expect to have other than the most general descriptions until the island is surveyed by thoroughly competent men. In the absence of something more complete, I hope that the following notes on the volcanic phenomena of Central Madagascar may not be unacceptable to your readers, and may prove a contribution, however slight, to our knowledge of the geology of this great island. And first let me mention the volcanic cones, of which there are many scores, probably hundreds, in the part of the island of which we are speaking. These volcanic cones are situated in two localities especially: in Mandridrano, on the western side of Lake Itasy, and in the neighbourhood of Betafo in Vakin' Ankaratra; the former being from 50 to 60 miles west, and the latter from 70 to 80 miles south-west, of Antananarivo, the capital. Both localities are about 130 miles from the sea on the eastern side of the island, and 150 on the western side. It is hardly necessary to say that all these volcanoes are extinct, and that there are none in activity at the present time in any part of Madagascar.[1] On the west side of Itasy the volcanic cones exist in great numbers, and these, therefore, shall be first described.

The extinct volcanoes of this district of Mandridrano extend for a distance of about 20 miles north and south, and perhaps 3 or 4 east and west. They are, for the most part, scoria cones. The cones are thickly studded over the district, in some parts clustering together more thickly than in others. There is no single large volcano to which the others are subsidiary, or upon which they are parasitic. Occasionally there is a series of cones which have evidently been heaped up by the simultaneous ejection of scoriæ from different vents situated on the same line of fissure, but so that the cones have run one into the other, leaving a ridge, generally curvilinear, at the summit. None of these extinct volcanoes reach the height of 1000 feet. Kasige, which is probably the highest, I found by aneroid to be 863 feet above the plain (5893 feet above the sea). Andranonatoa is perhaps next in height to Kasige. Kasige is a remarkably perfect and fresh-looking volcano, whose sides slope at an angle of about 40°. The scoriæ on the sides have become sufficiently disintegrated to form a soil on which are found a by no means scanty flora; for among other plants growing here I found an aloe (*A. macroclada*), and clematis (*C. trifida*), two or three Composite herbs (*Senecio cochlearifolius*, *Helichrysum lycopodioides*, *Laggera alata*, &c.), some grasses (*Imperata arundinacea*, &c.), a species of Indigofera, and an orchid. On its top is an unbreached crater, which measures, from the highest point of its rim, 243 feet in depth. It may be mentioned in passing, that on the very summit, in a hollow "cinder," there were found a small piece of money, perhaps of the value of a halfpenny, and a small bead, as also a portion of a banana leaf, with a few pieces of a manioc, and two or three earth-nuts placed upon it these had been deposited there by some of the heathen inhabitants of the place as a votive offering either to their ancestors or to the Vazimba (the aborigines of Central Madagascar). Continuous with Kasige, and adjoining its south side, though not so high, there is another volcano, Ambohimalala, and dozens of others are to be seen near by.

One thing with regard to these volcanic piles soon strikes the observer, which is, that they are frequently lop-sided, one side of the crater being higher than the other. The higher side varies from north to north-west and west. This is undoubtedly accounted for by the direction of the wind during the eruption, causing the ejected fragments to accumulate on the leeward side of the vent. Now we know that the south-east trades blow during the greater part of the year in Madagascar, hence the unequal development of the sides of the cones. The same thing may be also observed in the volcanic piles in the neighbourhood of Betafo. This phenomenon, as is well known, occurs also in other parts of the world.

A very large number of the cones have breached craters, whence lava has flowed in numerous streams and floods, covering the plains around. These streams and floods consist in every instance, I believe, of black basaltic lava; a sheet of this lava, the mingled streams of which have flowed from Ambohimalala and some other vents, has covered the plain at the foot of Kasige to such an extent as almost to surround the mountain. Similar sheets are to be seen in other parts of the district, but they are so much alike that a description of one will suffice for all. Amboditaimamo (or Ambohidratrimo?) is a small volcano to the north of Lake Itasy, and at the northern confines of the volcanic district. It possesses a breached crater turned towards the east; from this has issued a stream of lava which, following the direction of the lowest level of the ground, has swept through a small valley round the northern end of the mountain, and spread out at its west foot. This sheet of lava, which is horribly rough on the surface, occupies but a small area of some two or three square miles. It has been arrested in its flow in front by the side of the low hills. It is cut through in one part by a stream which, in some places, has worn a channel to the depth of 80 or 90 feet. Its surface, which is slightly cellular, is covered by some hundreds of mammiform hillocks, which must have been formed during the cooling of the liquid mass. The hillocks are mostly from 20 to 30 feet high, and apparently are heaped-up masses of lava, and not hollow blisters. The lava itself is black, heavy, and compact, being porphyritic with somewhat large crystals of augite. As yet it is scarcely decomposed sufficiently to form much of a soil, though grass grows on it abundantly, and a few other plants are to be seen.

A little to the south of Amboditaimamo there is another volcano, known by the name of Andrarivahy. It is situated on the summit of a ridge of hills—astride of it, so to speak—and from its crater there has been an outflow of what must have been very viscid lava, for, though the sides of the volcano and the ridge of hills form an angle of from 30° to 40°, the ejected matter has set or "guttered" on the slope, only a small portion of it having reached the valley below. This ridge of hills, through which the volcanic orifice has been drilled, is composed entirely of gneiss; and indeed it may be here stated that the whole of these volcanoes, as is the case also with those about Betafo, rest upon a platform of gneiss, chiefly garnetiferous.

Throughout the district numerous fragments of basic lava, trachyte, trachytic tuff, and basaltic conglomerate lie scattered about in abundance. The trachyte is of various shades of yellow and gray, and frequently porphyritic with large crystals of sanidine. Pumice, obsidian, and pitchstone do not seem anywhere to be found.

In addition to the numerous scoria-cones, there may be seen here and there in the district some half-dozen or more bell-shaped hummocks of trachyte. They are for the most part composed of a light-coloured compact rock. This rock, having originally had a highly viscid or pasty consistency, has evidently accumulated, and set immediately over the orifice through which it was extruded; such hummocks are Ingolofotsy, Beteheza, Angavo, Ambasy, Isahadimy, Ambohibe, Antsahondra, &c. Ingolofotsy, situated to the north-west of Itasy, is perhaps the most striking in appearance of these trachytic hummocks. It bears some resemblance to a bell or Turkish fez, except that its sides are furrowed with water-channels and its truncated summit is notched in a remarkable manner. Its height above the plain is 665 feet (5258 feet above the sea); the inclination of its sides averages probably 50° Adjoining Ingolofotsy on the south-

[1] Scrope, in his "Volcanoes," second edition, p. 428, says of Madagascar, "There is some reason to believe in the existence of active volcanic vents in this great island;" and Dr. Daubeny, in the second edition of his "Volcanoes," p. 433, in referring to the islands on the eastern coast of Africa, says: "The principal of these are the great Island of Madagascar, the Isle of Bourbon, and the Mauritius, the first of which has been too little explored to allow of my announcing with certainty anything respecting its physical structure;" and in a note he adds: "Madagascar is stated by Daubuisson to contain volcanoes, on the authority of Ebel (*Bau der Erde*, tome ii. p. 289), who reports that in this island there is a volcano ejecting a stream of water to a sufficient height to be visible 20 leagues out at sea." What remarkable eyesight those from whom Daubuisson heard the story must have had to see an invisible phenomenon so far away! Dr. Daubeny continues: "Sir Roderick Murchison, December 1827, exhibited at the Geological Society some specimens of a volcanic nature, said to have come from this island, but the locality was not mentioned."

west is Betelieza, a large mass of trachyte which has probably welled out from an orifice on the same line of fissure from which Ingolofotsy was extruded. Angavo is another of these trachytic domes. One singular feature in this mountain is its numerous shallow water-channels, which make their way down from the summit in a surprisingly regular manner (at least on the north side), giving the appearance of an opened umbrella with numerous ribs. From one point of view I counted as many as thirty-four of these channels. It may be mentioned in passing that, in a valley at the west foot of Angavo, there is a small crater whose lips are level with the surface of the ground. This may perhaps be accounted for by supposing that the ejected materials from this and other craters near have so accumulated

as to raise the level of the valley between up to the rim of the crater, and so obliterate the cone, probably never of any great height.

It is hardly necessary to say that these extinct volcanoes of Mandridrano must have been in activity in comparatively recent times. Possibly they belong to the historic period, though no tradition lingers with regard to their being in a state of eruption.[1] That they are, at any rate, of recent date, is shown by the almost perfect state of preservation in which most of the cones are still found, and by the undecomposed (or but slightly decomposed) character of the lava-streams that have issued from them. There have been no terrestrial disturbances or modifications of any magnitude since the days of their fiery energy; the conformation of hill and dale was the same then as now, for, in every instance, the lava-streams have adapted themselves to the form of the existing valleys.

Another feature worthy of mention in this volcanic district is the lakes and marshes which occupy many of the valleys. Itasy is the largest of the lakes, and Ifanja the largest of the marshes. Now most of these lakes and marshes have been doubtless formed by the sinking in of certain portions of the district, a fact made evident by the two following circumstances:—(*a*) On the south side of Kasige the gneiss may be seen distinctly to take a sudden dip beneath the volcanic pile, showing that, as the matter has been discharged from below, there has been a settling down of the cone, a fact made further evident by the existence of a small sheet of water, known as Bobojojo, in the immediate vicinity. But (*b*) on the western side of Ifanja marsh there is a small pond known as Mandentika. In the time of King Andrianampoinimerina, about a century ago, so the people say, there was a headland projecting into this pond, upon which was situated a small village of two or three houses. On a certain unhappy day the foundations of this headland suddenly gave way, and down it sank with the village and its inhabitants, only one of the latter escaping. From that time the pond has been appropriately termed Mandentika ("sinking"), but previous to the catastrophe it was known as Amparihimboahangy. There is no doubt as to the truth of this story, as I have myself seen traces of the submerged headland and village appearing just above the surface of the water. The natives of the place say that the sinking was caused by a Fananimpitoloha, a seven-headed, mythical, serpent-like monster that is supposed to live beneath the water.

Ifanja Marsh is some four or five miles from one end to the other, and perhaps a mile or more wide in its greatest width. It runs in a northerly and southerly direction, with its southern end bending round towards the west, at the foot of which is the volcano of Amboditaimamo, mentioned above. The marsh is 3700 feet above the sea, forming a considerable depression below the surrounding country, which is about 5000 feet in altitude. At its south-eastern corner there are some hot springs which are much resorted to by sick folks.

Lake Itasy covers ground, roughly speaking, to the extent of about 25 square miles. It may not improbably occupy an area of depression due to volcanic action;[1] but be this as it may, there is a cause at its outlet sufficient to account for its formation. Here, lying in the river-bed, may be seen numerous blocks of gneiss, many of them blackened with a covering of oxide of iron; and beneath this gneiss lava may be seen. Several volcanoes cluster round the outlet; but there is one—an inconsiderable hill—situated on the southern margin of the outflowing river, just above the rapids. There distinctly enough may be seen a low and much-worn crater, with its breached side facing the outlet; and gneiss blocks may be traced from the bed of the river all up the hill-side to the crater. There has apparently been first an ejection of volcanic matter, followed probably by an explosion tearing up and flinging out the gneiss through which the vent was bored, hence the gneiss blocks are superimposed upon the lava. Thus the water has been ponded back. The river has now cut its way several feet through the barrier thus thrown across its course; and by this continual erosion at its outlet, and the accumulation of sediment, and the growth of vegetation at its head, the lake is slowly, though surely, decreasing in extent year by year.

It seems that the lava also occupies the bed of the river further down, as Mr. W. Johnson says: "Went down the Lilia as far as the waterfall at Ambohipo. A more beautiful fall I think I never saw. The river, broken into three streams, falls in foaming white masses over an edge of black lava some 50 feet deep. The whole bed of the river for a mile above is of the

[1] I was told by a native that near the village of Ambohiriana, north of Angavo, and not far from Ingolofotsy, there is an emission of gas (? "fofona"), and that the people say that formerly fire was to be seen. The place is named Afotrona ("afo," fire; and "trona," grunting or hard breathing).

[1] Mr. W. Johnson says: "I am told here that Itasy was once a huge swamp, and that its becoming a clear lake is within the knowledge, or perhaps the traditions, of the people." If this be really true, it can only be explained on the supposition that there has been a recent subsidence of what is now the bed of the lake, as in the case of Mandentika, mentioned above.

Mr. Sibree says: "The natives say that the lake Itasy . . . was formed by a Vazimba chieftain, named Rapeto, damming up a river in the vicinity and so the rice-fields of a neighbouring chief with whom he was at variance were flooded, and have ever since remained under water."—"The Great African Island," p. 136.

same black character, the lava broken in innumerable blocks, and setting out in vivid colour the verdure of the river banks."

A good deal of what has been said respecting the volcanic district of Itasy also holds good in regard to that of the Betafo valley and neighbourhood, where, however, the volcanic cones are fewer, and where trachytic domes do not appear to exist. One of the volcanoes in the Betafo valley, Iavoko, is of greater dimensions, and has a much larger crater than any to be found about Itasy. From this volcano a large sheet of basaltic lava has issued, upon which are to be found in abundance various species of plants, notably a Euphorbia and a stonecrop (Kitchingia). Almost all the plants growing on this lava-bed, however, are of a succulent character, and can dispense with soil, requiring merely a foothold. On the sides of Iavoko may be picked up fragments of calcined gneiss, which have been torn from the sides of the vent in the passage upward of the volcanic matter. On some of the cones numerous crystals of augite as large as marbles may be found among the volcanic debris. There is one volcano, Tritriva, near Betafo, which, inasmuch as it is different in character from any others mentioned above, deserves a few words. It is one of those volcanoes off which the summit has been blown by explosive action, leaving what is known as a crater-ring, which is now the site of a small lake. The lake is not more than 100 or 200 feet in diameter, perhaps not as much as that; but there is reason to suppose that it is of very great depth. The inner sides are steep for the greater part of the circumference, but on one side the lake is easily accessible.

It is possible that, when the country is more thoroughly explored, it may be found that the volcanoes near Itasy and those in the Betafo valley are connected by intermediate ones; indeed, on Dr. Mullens's map several craters are shown somewhat west of a straight line drawn between these two volcanic districts.

About 25 or 30 miles to the north-east of Antananarivo I discovered, a couple of years ago, several small volcanic craters. These also seem to belong to the class of crater-rings or explosion craters. Although fragments of volcanic matter have been ejected from them, they are not in such quantity as to form a cone; and the craters, none of which exceed 100 yards in diameter, and 30 feet in depth, have been formed probably by a single explosion of the pent-up forces below. With the exception of scoriæ and lapilli, which are sparingly scattered about, there is no visible sign of volcanoes, and one may come to the very verge of the craters before being aware of their existence. Two of the largest craters consist of saucer-shaped depressions, but are rather elliptical than circular in form; the others consist mostly of small cavities, deep in proportion to their width. Several of the craters are occupied by sheets of water, with rushes and other aquatic plants growing around their margin.

Besides the volcanic phenomena mentioned above, thermal springs occur in various localities in the interior of Madagascar. The following is an analysis by Dr. Parker of water from springs in the district of Antsirabe:—

"On evaporation, one pint (20 oz.) of water from each spring yielded the following quantities of solid salts:—

Spring No.	1	yielded	40	grs. of salt,	or	2	grs. to	1	oz. of	water.
,, ,,	2	,,	38	,,	,,	1·9	,,	1	,,	,,
,, ,,	3	,,	42	,,	,,	2·1	,,	1	,,	,,
,, ,,	4	,,	28	,,	,,	1·4	,,	1	,,	,,

All these springs contain the same ingredients, viz. lime, magnesia, soda, and potash, in combination with chlorine, iodine, sulphuric acid, and carbonic acid, with the addition of free carbonic acid gas."

At Antsirabe there is a deposit from one of these springs of carbonate of lime, which is occasionally used for building purposes in the capital. Bubbles of carbonic acid may be seen rising from the surface of the deposit, and at one point, where there is a small spring, a mass of calc-sinter has been formed which, speaking from memory, is probably 12 feet high by 18 feet long.

In one of the valleys in the vicinity of the crater-rings of Ambohidratrimo, spoken of above, there is a deposit of siliceous sinter. It appears in one or two places, scarcely rising above the surface of the ground, in a valley of rice-fields, and has been deposited by springs which have long since ceased to flow. The sinter is exceedingly hard and compact, and is used by the natives for fire-flints. In some portions of it numerous fossils of a species of Equisetum are embedded. The longitudinal striæ leave no doubt as to the nature of the plant. The fistular stem has been filled in, and the vegetable substance entirely replaced, by silex. The stems of some of these fossil plants are quite half an inch in diameter. Now, the only Equisetum found in Central Madagascar at the present time is *E. ramosissimum*, but this never attains to such a thickness as the Equiseta in the sinter; so that the fossil species have become extinct since the springs which deposited the geyserite were in a state of activity.

So little is known respecting earthquake phenomena in Madagascar, no scientific observations ever having been instituted, that it is scarcely worth while to refer to the subject. However, it may be stated that scarcely a year passes without one or more shocks being experienced in Central Madagascar, though they are never severe or of long duration; and the destruction caused by these earth-waves in some parts of the world is entirely unknown here. The natives, I may say in passing, strangely imagine that earthquakes are caused by a whale (Trozona) turning on its back.

Extinct volcanoes and thermal springs exist also in other parts of the island, but so little is known about them that I can do no more than merely allude to their existence. R. BARON

Antananarivo, Madagascar, December 2, 1885

Coal-Dust and Explosions

THOSE who have given the labours and conclusions of workers antecedent to, and contemporaneous with, Mr. W. Galloway, on the subject of the part played by coal-dust in mine explosions, the careful consideration which these merit in common with the results and writings of that zealous exponent of the question, will hardly feel disposed to concur in his conclusion that, except by him, "the very simple, and yet all-important, element" to which he refers in his recent letter has been treated with neglect.

On the other hand, they will consider that when Mr. Galloway "goes the length of crediting coal-dust with the *rôle* of principal agent (in coal-mine explosions), and of relegating fire-damp to a secondary position," he altogether loses sight of some very obvious facts which forbid so sweeping a conclusion.

Any one who is led, by special interest in the subject, to study the forthcoming Report of the Royal Commission on Mine Accidents, will find that the important part which may be, and no doubt frequently is, taken by dust in coal-mine disasters is recognised to its full extent, and that, in a careful consideration of the accumulated knowledge on this subject, all due weight has been given to the experimental results arrived at by Mr. Galloway and others. FREDK. A. ABEL

March 3

Deposits of the Nile Delta

PERMIT me to say that Prof. Judd is in error in supposing that I intended to withdraw my statement that desert sand underlies the Nile alluvium at a very moderate depth. The general succession of the newer deposits of Lower Egypt, according to the information I have been able to obtain (and which I have endeavoured to state as plainly as possible) is as follows, in descending order: (1) Modern alluvium, varying from zero to about 40 feet, and of course more in old eroded channels. (2) Desert sand of the Post-Glacial continental period. (3) Pleistocene or Isthmian deposits, lacustrine, estuarine, or marine. The question is not whether this succession exists—that I am prepared to argue on other grounds—but whether it appears in any or all of the recent borings. It is scarcely necessary to say that such general succession admits of alternations at the junctions of beds, and of local absence of some of its members. On finding, however, that the recent borings had been stopped by quicksand at the depth of about 35 feet, and that this quicksand consisted of the rounded grains of desert sand, and was mixed with gray clay or marl, and concretions like those of the Isthmian formation, I naturally concluded that the succession above referred to was distinctly indicated. Prof. Judd now affirms, as I understand, that, in all the Delta borings, mud of "precisely similar mineral character" to that of the surface extends to the bottom. The evidence of this, as well as the promised consideration of the other points to which I have alluded, I am content to wait for till the report appears in full. J. WM. DAWSON

Montreal, February 18

On the Intelligence of Dogs

WHEN reading in NATURE of November 12, 1885, the abstract of Sir John Lubbock's paper "On the Intelligence of Dogs," I called to mind an incident of a little Blenheim spaniel which belongs to my mother.

The readers of NATURE may perhaps be a little tired of stories relating to the intelligence of the dog, especially when these are illustrations of the effects of training. My excuse for troubling you now is that the following incident seems to indicate a singular power of *reasoning*.

"Middy" was about nine months old when he was picked off the streets of Melbourne, and he had many traits of the "larrikins," as the human waifs there are called. He had been three months in our family, and we had almost begun to despair of breaking him in to civilised life.

One Sunday my sisters set off for Sunday-school, and were surprised, on nearing the church, to find "Middy" at their heels. He was told to "go home," and he was found at the house on their return. Nothing more was said on the subject, which was forgotten by the next Sunday. But when my sisters entered the school-room on that day, great was their amusement to see the little dog seated calmly as a scholar in one of the classes! He behaved quite quietly during the lessons, and then left with the children, and trotted home alone. To prevent constant repetitions of this behaviour, he had to be caught hours before school-time and shut up. He was very clever in evading capture—crept into hiding early in the day, and bolted when we were off guard. On these occasions he was certain to be found in his place at school.

It perhaps should be especially noted that "Middy" had never been to the church before, and that a whole week had elapsed between his first and second attempts.

MARY KNOTT

7, Kaga Yashiki, Tokio, Japan, January 20

Frost in Devonshire

THE Rev. A. D. Taylor, Rector of Church Stanton, a parish in Devonshire, some 900 feet above sea-level, writes me under date of the 22nd inst. :—

"We have had for three days the most wonderful rime. The trees have been covered, every twig and bud, with ice, on the average an inch at least in depth. I have measured several pieces, and have found them $1\frac{1}{4}$ to $1\frac{1}{2}$ inches from base to edge. The whole place has been like fairy-land, or a silver country. To-day it has all fallen, with a continuous rushing and rattling on the bushes for four hours. The very leaves of the laurels were so frozen that you could take off each leaf a perfect *ice-leaf*—an exact reproduction in transparent ice, of about twice the thickness of this (ordinary letter) paper, of the laurel leaf—every vein and unevenness of edge distinct and clear. The children collected scores of them, and very lovely they looked. I have never seen anything of the sort which would compare with it. The people call it *rängling* (phonetic spelling), a queer word of which I never heard before."

Keen frost in an excessively moist air no doubt sufficiently explains the beautiful phenomenon itself; but can any Devonshire man explain the country people's word?

Bregner, Bournemouth, February 24 HENRY CECIL

"Pictorial Arts of Japan"

IN my review last week of Mr. Anderson's "Pictorial Arts of Japan" I inadvertently wrote the "eight Nirvanas" of Gautama instead of the "eight incidents (more properly 'features'—*fa siang*) of the Nirvana." F. V. DICKINS

University of London, Burlington Gardens, W., March 1

DISCOVERY OF A NEW ELEMENT BY CLEMENS WINKLER[1]

IN the summer of 1885 a rich silver ore was found at Himmelsfürst, near Freiberg; it was pronounced by A. Weisbach to be a new mineral, and was named *Argyrodite*. T. Richter examined its behaviour in the blow-pipe flame, and found that it consisted chiefly of sulphur and silver together with a little mercury, which latter element has never before been found at Freiberg.

[1] From the *Berichte* of the Berlin Chemical Society, No. 3.

The author has analysed the new mineral, and finds that the amount of mercury only amounts to 0·21 per cent., whilst silver is present to the extent of 73-75 per cent., and sulphur to the extent of 17-18 per cent. He also finds a very small quantity of iron, and traces of arsenic. However often and however carefully the analysis was conducted, a loss of 6-7 per cent. always remained unaccounted for. After a long and laborious search for the source of this error, Clemens Winkler has at length succeeded in establishing the presence of a new element in argyrodite. *Germanium* (symbol Ge), as the new element is called, closely resembles antimony in its properties, but can, however, be sharply distinguished from the latter. The presence of arsenic and antimony in the minerals accompanying argyrodite, and the absence of a method of sharply separating these elements from germanium, made the discovery of the new element extremely difficult.

The author, having a more detailed communication in view, confines himself to the following particulars :—

When argyrodite is heated out of contact with the air, which is best effected in a current of hydrogen, a black crystalline and moderately volatile sublimate forms, which melts to brownish-red drops, and which consists principally of germanium sulphide, together with a little mercury sulphide. Germanium sulphide dissolves readily in ammonium sulphide, and, on the addition of hydrochloric acid, is thrown down again in a pure state as a snow-white precipitate, which is immediately dissolved when treated with ammonia; the presence of arsenic or antimony colours the precipitate more or less yellow.

On heating germanium sulphide in a current of air, or on warming it with nitric acid, a white oxide is produced which is not volatile at a red heat and which is soluble in potash solution; when the alkaline solution is acidulated and submitted to the action of sulphuretted hydrogen, the characteristic white precipitate is produced.

The oxide is readily reduced by hydrogen, whilst the sulphide on account of its volatility is more difficult to reduce. The element, like arsenic, has a gray colour and moderate lustre, but is volatile only at a full red heat, and is decidedly less volatile than antimony. Its vapour condenses to small crystals recalling those of sublimed iodine; these show no tendency to melt and could not be confounded with antimony.

When germanium or its sulphide is heated in a current of chlorine it yields a white chloride which is more readily volatile than antimony chloride; its acidulated aqueous solution yields a white precipitate with sulphuretted hydrogen.

The author intends to undertake the determination of the atomic weight of germanium, even if it can be decided only approximately, as this will show whether the new element is to occupy the vacant position in the periodic system between antimony and bismuth.

THE STORY OF BIELA'S COMET[1]

II.

BRANDES, one of the two German students spoken of, was riding in an open post-waggon on the night of Dec. 6, 1798, and saw and counted hundreds of these shooting-stars or meteors. At times they came as fast as six or seven a minute. These meteors which Brandes saw that night we know now were bits from Biela's comet. In November 1833 occurred the famous star-shower, which some of you saw. The facts of that shower gave to two New Haven men, Profs. Twining and Olmsted, the clue to the true theory of the shooting-stars. From that date

[1] A Lecture delivered by Prof. H. A. Newton, on March 9, 1874, at the Sheffield Scientific School of Yale College, U.S. From the *American Journal of Science*. Continued from p. 395.

shooting-stars have belonged to astronomy. The November meteors were admitted a new constituent of the solar system. Three years later, M. Quetelet, of Brussels, found that shooting-stars are to be seen in unusual numbers about August 10 of each year. A few months afterwards Mr. Herrick made independently the same discovery; but he also told us of star-showers in April and January. What Brandes had seen in December 1798 led Mr. Herrick, moreover, to expect a like shower in other Decembers, and he asked that shooting-stars be looked for on December 6 and 7, 1838. This shrewd guess was justified, for on the evenings of those days hundreds of these meteors were seen in America, in Europe, and in Asia by persons thus induced to look for them. These shooting-stars also had once been parts of Biela's comet, though this fact was not dreamed of at that time.

In the course of time we came to know more about the meteoroids: that in general they moved in long orbits like comets, rather than round ones like planets; that some of them were grouped in long, thin streams, many hundreds of millions of miles long, and that it was by the earth's plunging through these that we have star-showers; that the space travelled over by the earth has in it everywhere some of these small bodies, probably the outlying members of hundreds of meteoroid streams.

Also the periodic time and the path of the stream of November meteoroids were found out. Then came the interesting discovery that in this stream, and in that of the August meteoroids, lay the paths of two comets. Then Dr. Weiss of Vienna showed that the meteors seen

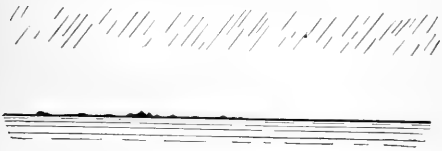


FIG. 9.

by Brandes in 1798, and by Herrick in 1838, as well as many meteors seen near December 1 of other years, and the Biela comets, all belonged to each other.

It is then properly a part of my story to show you the behaviour of one of the streams of meteoroids. Standing several hundreds of miles away, see them enter the upper atmosphere. They are entirely unseen until they strike the air. They then come down like drops of fiery rain a few miles, in parallel lines, burning up long before they reach the ground (see Fig. 9). The air is in fact a shield, protecting the men below from a furious bombardment. The region of the luminous tracks is many miles above that of the highest mountains.

Go farther away. Parallel lines may show the paths of the meteoroids (Fig. 10), though the bodies themselves are too small to be seen. They strike a little way into the air, to some persons coming from the zenith, to some coming obliquely, to some skimming through the upper air—and unseen by all upon one whole hemisphere. I need hardly remind you that sunlight, and twilight, and clouds often come in to prevent the seeing of the star-flights by persons below.

Go still farther away. From outside look in toward the sun upon the earth and meteoroid stream. The meteoroids in fact are not to be seen. The stream is of unknown depth, perhaps millions of miles deep. Its density increases in general toward the centre. We cross the densest part of the November stream in 2 or 3 hours, and the whole of it in 10 or 15 hours, while the passage of the August stream requires 3 or 4 days. The Biela stream is crossed obliquely, the meteoroids overtaking the earth. The August stream is nearly perpendicular, and the November stream meets the earth.

Again go still farther away, out to the point from which we first looked down upon the earth and comet. We then see (by the mind's eye) the meteoroids strewn along the elliptic orbit of the comet for hundreds of millions of miles, forming a stream of unknown breadth, but in the

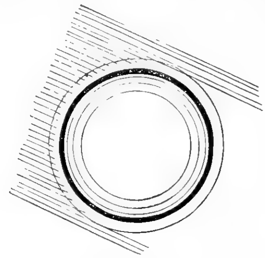


FIG. 10.

scale of the first figure shown you about $\frac{1}{50}$ of an inch in thickness.

Come back now and stand inside the stream, at its densest part. You in fact see nothing; but the meteoroids are all about you scattered quite evenly, and distant each from its nearest neighbours 20 or 30 miles. They all travel the same way and with a common motion.

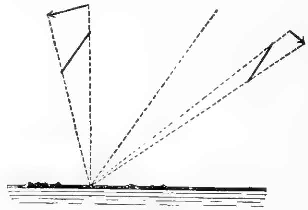


FIG. 11.

Once more change your place and look up from the earth's surface. The meteoroids can now be seen, for when they strike the air they burn with intense light, becoming shooting-stars. As it is from this position only that we ever see them, note their behaviour with more care. A shooting star coming toward you appears only as a bright stationary point in the sky. That point is a

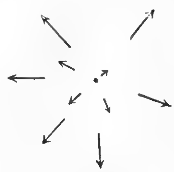


FIG. 12.

marked one in every star-shower, and is called the radiant. The meteors to the right and left of the stationary one are, in fact, moving in the common direction, but they seem to move in the sky away from the radiant (Fig. 11). In other words, the tracks produced backward will all meet in one point in the sky (Fig. 12). This radiant-point may be in the horizon, or in the zenith, or at any place between. It will in general rise in the east and set in the west, like the sun or a star, keeping always its fixed place among the stars.

Need I tell you how much we would like to have some of these bits from the meteoroid streams to handle, to try with the blowpipe and under the microscope, perhaps thus to learn something of their history? We do have something like this. At times large meteor masses come crashing into the air. They burn with a light bright enough to be seen over several States. Coming down usually a little lower than the shooting-stars, most frequently to a height of 25 or 30 miles, they break up with a noise like the firing of heavy artillery, to be heard over several counties. Fragments scattered in every direction fall to the ground over a region 10 or 20 miles in extent. I can show you several such fragments. There are over a hundred of them in our College Cabinet, one of which weighs nearly a ton.

Between these stone-producing meteors and the faintest shooting-star I cannot find any clear line of division. We have meteors that break with a loud detonation, but no fragments are seen to fall. One such was seen in 1860 from Pittsburgh to New Orleans, and from Charleston to St. Louis. It exploded over the boundary line of Tennessee and Kentucky. We have others which are only seen to break into pieces, no noise being heard. Then we have those which quietly burn out. Like the larger ones, these may leave smoky trains that last for minutes. One such I have seen for 45 minutes as it slowly floated away in the currents of the upper air.

Thus through the whole range, from the meteors that give us these stones and irons for our museums, down to the faintest shooting-star hardly seen by a person watching for it, we pass by the smallest differences. They differ in size, in colour of flame, in direction, in train, in velocity. But in astronomical character all seem to be alike. They move in long orbits like comets, and like comets at all angles to the earth's orbit. In fact, a meteoroid is a small comet, not having, however, the comet's tail.

Let us turn from this long digression again to the story of Biela, and tell you what we saw of it in November 1872. We of course looked for a few fragments from the comet the last week in November, but not quite as early as the 24th. But on that evening they came, in small numbers it is true. Before midnight we saw in New Haven about 250 shooting-stars, three-fourths of them from Biela. Very few of them were to be seen the next morning and evening. Then for a day or two it was cloudy. But in the early part of the evening of the 27th they came upon us in crowds. Over 1000 were counted in an hour. By 9 o'clock the display was over. But we saw only the last few drops of a heavy shower. Before the sun had set with us the shooting-stars were seen throughout all Europe, coming too fast to be counted. At least 50,000, perhaps 100,000, could have been seen then by a single party of observers.

Notice what was really seen. Here is a chart of the paths of the shooting-stars as actually seen on that evening, and drawn with care at the time upon maps of the stars (Fig. 13). You see a few stray flights cutting wildly across the others. These are strangers to the system.

You see also that the paths do not, as we had reason to expect, all meet in one point. This is not due to errors of observing, for we see it in every star-shower. It is probably because the small bodies glance as they strike the air, just as a stone skips on the water. In fact, we often see the meteors glance in the air—the paths being crooked.

The meteors came from the northern sky. A German astronomer, Prof. Klinkerfues, at once thought that if this was the main body of the comet it ought to be visible as it went off from us. For this, however, we must see the southern sky. He telegraphed to Mr. Pogson at Madras in India: "Biela touched earth Nov. 27. Search near Theta Centauri." Mr. Pogson looked for the comet and found it. On two mornings he saw a round comet with decided nucleus, and having on the second morning a tail 8′ long. But clouds and rain returned the next day. This is the last that has been seen of Biela's comet.

Was this Pogson comet one of the two parts of Biela seen in 1845 and 1852? This is yet an open question among astronomers. It may have been, but I think it was not. The Biela comets should have been nearly 200,000,000 miles away. Their orbits had been computed with care. The comets, as single or double, had been observed for 80 years, that is 12 revolutions, and we knew well their orbits. All known disturbing forces had been allowed for. It could hardly be that they should have gone so large a distance out of the way. It is much more probable that this was a third large fragment, thrown off centuries ago. The two observations made by Mr. Pogson were not enough to compute an orbit from, but they do

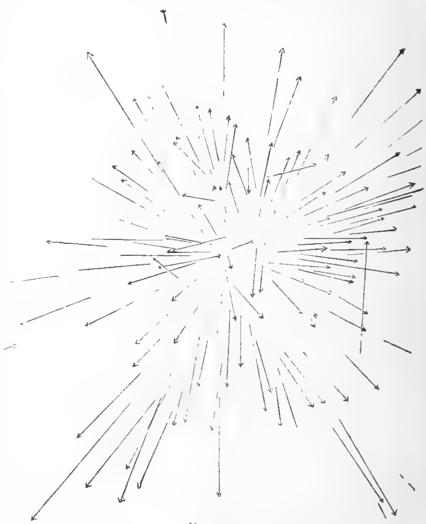


FIG. 13.

show that his comet was very near us, and were such as one travelling in the Biela stream might give. But they also show that the earth did not pass through the Pogson comet centrally.

Orbit of the Biela Meteors.—In 1798, when the earth was at N, and Brandes saw the fragments from Biela, the comet was at C (Fig. 14). In 1838 Mr. Herrick and others saw such fragments of the comet at N, 300,000,000 miles ahead of the main body at A, and in 1872 we met like fragments at N, 200,000,000 miles behind the main body, which should have been at B. Thus the fragments are strewn along the comet's orbit, probably in clusters, for at least 500,000,000 miles.

My story of Biela's comet and of its fragments has covered 100 years. Do we get any glimpses of its earlier life, and can we guess how it grew into its present shape? Yes, we may make our hypothesis. But we must not forget that to tell others how God must have made the world is bewitching to many minds, and that of the thousands of trials at world-building almost all have been grievous failures. With this caution let me give you a plausible form of this early story of Biela.

Once upon a time, hundreds of thousands of years ago, this comet was travelling in outer space, among the fixed stars, too far away to be attracted by the sun. What I mean by this outer starry space may be told by the help of the pictures I have shown you. In them the earth's distance from the sun is 10 inches, and the comet's longest range about 5 feet. Upon the scale of these figures only a few of the nearest fixed stars, perhaps two or three only, would be in the State of Connecticut. In this starry space the comet was travelling. What had happened before I do not try to guess. How, when, by what changes, its matter came together, and had become solid, I do not know, nor whether, in fact, it had not always been solid.

In the course of time its path and the sun's path through space lay alongside of each other, and the sun drew the comet down toward itself. If the comet had met no resistance as it ran around the sun, whether from the ether that fills space, or from the sun's atmosphere, and if it had not come near any of the planets, it would have gone off again into outer space whence it came. Some such cause robbed it of a little of its momentum, and it could not quite rise out of the sun's controlling force, but it came around again in an elliptic orbit to remain thenceforth a member of the solar system. It may or it may not then have been a great comet, like Donati's (in 1858).

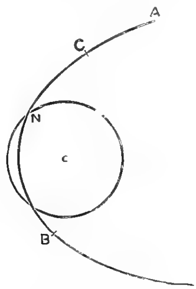


FIG. 14.

It was probably a small one. It may have made its circuit of the sun in tens of years or in tens of thousands.

At some time, probably in the early historic ages, it came near the huge planet Jupiter. When it had gone out of his reach it had just momentum enough left to go around the sun in its present orbit of $6\frac{2}{3}$ years. It went away from Jupiter an entire and single comet. As it came near the sun, his burning heat acting upon the cold rocky body of the comet cracked off and scattered in every direction small angular bits. At the same time a very thin vapour, shining by its own light, was set free. To this vapour both comet and sun had an unaccountable repulsion. It was driven off first by the comet every way. But soon that which was sent toward the sun was driven back again, and it went streaming off into space to form the comet's tail, a process ably set forth by Prof. Norton.

This matter which made the tail of the comet never got back. It had, moreover, nothing whatever to do with the meteoroid stream. The meteoroids are solid fragments. To them the sun, at least, had little repulsion. The comet was so small that perhaps the force with which a boy can throw a stone would have sent the bits of stone entirely off the comet, never to come back. Those which were shot forward from the comet near P (Fig. 1) went up along the orbit with greater velocity and rose higher from the sun than the comet did near D. Having a longer road to travel, they took a longer time to come around to P in each circuit. On the other hand, those bits which were shot backward followed the comet with less velocity and could not quite rise to D, and so having a shorter road to go over came sooner back to P, gaining on the comet at each circuit. Thus the stream grew longer slowly, and new fragments being thrown off at each circuit, the meteoroid stream grew in length to its hundreds of millions of miles. At times, the main comet has broken into two or more parts, giving us the double comets of 1845 and 1852, the Pogson comet of 1872, and the double meteor stream of November 1872.

THE NAVIGABLE BALLOON[1]

M. RENARD, captain of the Chalais-Meudon navigable balloon, has presented to the French Academy of Sciences a report of the experiments made with that balloon last year. Before starting on a fresh campaign in 1885, it was found necessary to make certain modifications in the construction of the balloon, affecting the ventilator, voltaic piles, commutators, &c. To measure the velocity of the balloon, an anemometer, the registrations of which would be too strong, seeing that the spiral is placed in front, was impracticable. There was no inconvenience, on the other hand, in the use of an aërial log. A balloon of gold-beater's skin, 120 litres in capacity, was accordingly filled in part with common gas, so as to keep exactly in equilibrium in the air. This balloon was attached to the central extremity of a bobbin of silk thread just 100 metres in length. The slightest effort is sufficient to unroll this bobbin when the central thread is drawn. The other extremity of the thread is wound round the finger of the operator. To obtain a measurement of speed the balloon is let go, when it quickly flies to the rear, and, on reaching the end of its line, conveys a perceptible indication of the fact in the finger holding the thread. The instant of its departure and that of the twitching sensation in the finger at its terminus are marked on a chronometer counting tenths of a second. Although the force transmitted to the small balloon during the unwinding of the thread is very slight, it is yet necessary to take account of it. Repeated trials in a closed place showed that the little balloon swerved 7 metres per minute, or 0·117 metre per second, under the influence of this light effort. If, then, t be taken as the time in seconds elapsing in the process of unwinding, the way traversed by the navigable balloon during the opera-

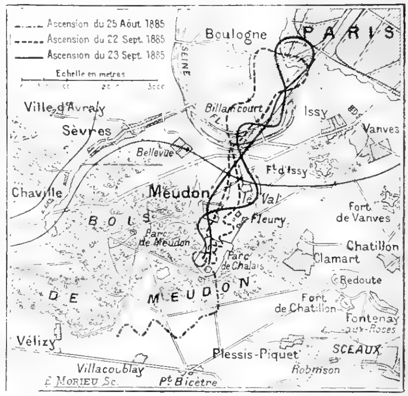


FIG. 1.—Map of the journeys of the *La France* balloon.

[1] From *La Nature*.

Fig. 2.—The *La France* above the Point-du-Jour, Paris. Facsimile of an instantaneous photograph executed at the Observatory of Physical Astronomy, Meudon.

tion of unwinding will be 100 + 0·117 t, and the speed of the balloon will be given by the formula—

$$S = \frac{100}{t} + 0{\cdot}117.$$

The preparations above referred to having been all completed, on the first fine day thereafter, August 25, the new mechanism was put on its trial, and behaved in a manner leaving nothing to be desired.

The balloon, which had been already filled for a certain time, having lost a considerable portion of its ascending force, M. Renard was under the necessity, on this occasion, of dispensing with the services of a third aëronaut, and mounted in the company solely of his brother, Capt. Paul Renard. The wind blew from the east. The speed measured at a low height by means of small balloons, appeared to be no more than 5 metres a second. Taking as a basis the approximate values of the preceding year, they calculated on obtaining a proper speed of nearly 7 metres per second, and were greatly surprised at being unable to gain the aërial current which prevailed at 250 metres above the valley of Chalais. The spiral, launched at fifty-five rounds per minute, proceeded with perfect regularity, yet they fell back—slowly, indeed, but continually. Desiring, nevertheless, to continue the experiment, and fearing to be carried away above the woods of the Chaville quarter, M. Renard turned the head of the balloon a little to the right, and soon, under the combined action of the wind and its own speed, it took a southern direction, and, the backward movement continuing, alighted after a voyage of 50 minutes close by the farm of Villa Coublay, whither he had directed it.

By reason of the bad weather the second definitive experiment did not come off till September 22, when the wind was blowing from the north-north-east—that is, from Paris, and its velocity in the lower strata varied from 3 to 3·50 metres per second. This time the aëronauts had their full complement of three: Capt. Renard at the helm and the motory machine, Capt. Paul Renard taking measurements and various observations, and, in addition, M. Duté-Poitevin. They started at 4.25 p.m. in a moist and foggy atmosphere. The spiral was set in motion and the head directed towards Paris. Though at first inclined to yaw, the course of the balloon soon righted itself, and, crossing the railway line above the station at 4.55, the balloon reached the Seine towards the western extremity of the island of Billancourt at 5 o'clock. Here, a measurement being taken, the progress of the balloon was found to be precisely 6 metres per second (time of unwinding = 17″, whence

$$S = \frac{100}{17} + 0{\cdot}117 = 5{\cdot}882 + 0{\cdot}117 = 5{\cdot}999 \text{ m}).$$

At 5.12 p.m., after an excursion of 47 minutes, the balloon entered the enceinte by the bastion 65. It was only the increasing damp and fog which induced the aëronauts to cut short their voyage and make for home. The turning of the balloon was easily effected, and, aided this time by the aërial current, it approached its point of departure, which was entirely concealed by the fog, with surprising rapidity, retracing in 11 minutes the road it had taken 47 minutes to cover in going. The aërostat tacked about at first to keep its head to the wind, and in 10 minutes the little skiff touched the sward, whence it had ascended. During this voyage the balloon mounted to only 400 metres above the ground.

The next day before Gen. Campenon, Minister of War, and Gen. Bressonnet, President of the Committee of Fortifications, the balloon, *La France*, performed a fresh ascent with a success equal to that of the previous day. The itinerary of this voyage was much the same as that of the 22nd. The wind was weaker and bore the balloon to Paris. The time of the passage was 17 minutes going, 20 returning. The landing was very easy, and the balloon returned to the precise spot of its departure. The voyage could not be further prolonged for lack of ballast, the previous ascent having cost the balloon a partial loss of its ascending force.

On the valid basis of the experiments above described, M. Renard lays down some fundamental formulæ for calculating the resistance of balloons of construction analogous to that of *La France* with network and car.

Let R be the resistance in kilogrammes of the balloon *La France*, moving by the point; S, its speed per second in metres; θ, the work of direct traction (motory work in kilogrammetres); T, the work of the propelling screw shaft (in kilogrammetres); T', the work at the limits of the motive power in kilogrammetres); then

$$(1) \quad \begin{cases} R = 1{\cdot}189\, S^2. \\ \theta = 1{\cdot}189\, S^3. \\ T = 2{\cdot}300\, S^3. \\ T' = 2{\cdot}800\, S^3. \end{cases}$$

At the rate of 10 metres, which would suffice for having the direction in most cases, we get

R = 118·9 kilogrammes.
θ = 1189 kilogrammetres.
T = 2300 kilogrammetres, or 31 horse-power.
T' = 2800 kilogrammetres.

In general for a balloon of D diameter (in metres) we would get

$$R = 0{\cdot}01685\, D^2 S^2.$$
$$\theta = 0{\cdot}01685\, D^2 S^3.$$
$$T = 0{\cdot}0326\, D^2 S^3.$$
$$T' = 0{\cdot}0397\, D^2 S^3.$$

It may be added that out of seven voyages, from August 9, 1884, to September 23, 1885, the aërostat has in five returned to its point of departure.

NOTES

WITH much regret we announce the death of the eminent Belgian botanist, Prof. C. J. E. Morren, of Liége, at the early age of fifty-three years.

AT a meeting of the Managers of the Royal Institution, held on Monday, March 1, the Actonian Prize of one hundred guineas was awarded to Prof. G. G. Stokes, P.R.S., for his lectures on Light, in conformity with the Acton Endowment Trust Deed. The following alteration has been made in the lecture arrangements before Easter:—Prof. Dewar, F.R.S., will begin a course of four lectures on Electro-Chemistry, on March 25, in place of Prof. Tyndall, F.R.S., on Light.

DR. JULIUS VON HAAST, C.M.G., F.R.S., the eminent geologist and Director of the Canterbury Museum, New Zealand, who is charged as Commissioner with the exhibits from that colony for the Colonial and Indian Exhibition, has arrived in London, and is busily at work in carrying out all the preliminary arrangements of the extensive court allotted to New Zealand. Dr. von Haast has been exceedingly successful in his journeys through the colony in obtaining large and valuable collections illustrating the fauna, flora, and geology, as well as collections of the art and industry of the Maori tribes. The food and other fishes, the birds, the timbers, as well as other native products and local industries will be well represented.

M. PASTEUR, at the last sitting of the Paris Academy of Sciences, stated that out of 325 cases of inoculation for hydrophobia, only one had failed—namely, that of the youth Pelletier, who came too long after being bitten, and under very unfavourable conditions. He advocated the establishment of an international hospital, to which patients would come from all parts of the world; and he suggested a discussion as to the locality and the fund for its support. At the close of the meeting Prof. Pasteur announced that he should next investigate whether diphtheria could not be treated by a similar process to that which he had found so successful against hydrophobia.

M. CHEVREUL caught a cold a few days ago, and some anxiety was entertained for his health, owing to his great age rather than to the gravity of the indisposition. We are glad to learn that he has since improved. His 101st birthday will take place on August 31 next.

IT is probable that the Observatory of Montsouris will be discontinued as an independent establishment. M. Marie-Davy will be placed on the retired list, and the credits paid in support of Montsouris suppressed entirely. It will become the headquarters of the Central Bureau of French Meteorology.

THE *Colonies and India* states that it is the intention of Mr. Morris, on leaving Jamaica to take up his appointment at Kew, to make a tour of the West India Islands for the purpose of becoming personally acquainted with their circumstances and resources, and with the view of being able afterwards to give them advice and assistance in the development of new industries. Several of the islands have already been visited by him, but it is said to be his intention to make now a careful study of their circumstances, to be afterwards embodied in a special report, or utilised in directing the resources of Kew to the amelioration and improvement of West Indian industries.

AT the Scottish Geographical Society on Tuesday afternoon, March 9, at 4 o'clock, a paper will be read by Prof. James Geikie, F.R.S., Vice-President of the Society, entitled "The Evolution of Europe."

THE Department of Public Works in Japan having recently been abolished as a separate office of State, much interest is felt, especially by scientific Europeans in the Japanese service, as to the future fate of the Imperial College of Engineering, which, since its establishment, has been under the control of the Minister of Public Works. It has been attached now to the Education Department, but it is uncertain whether it will remain a separate College or will be incoporated with the University of Tokio. In the latter case a considerable readjustment of the staff would take place, as the University has already professors of most of the subjects taught at the Engineering College, and a number of holders of Chairs of scientific subjects would be redundant. Commenting on this subject, the *Japan Mail* says that graduates of the College are found doing useful work in every part of the empire, and so high is the esteem in which they are held that to have been educated there is a certain passport to employment. It possesses the handsomest buildings and the most perfectly-equipped laboratories and museums of any educational institution in Japan, the University not excepted, and hence it would be a pity to destroy the individuality of an institution which has been so markedly successful. Accordingly it is suggested that the wisest plan would be to affiliate it to the University, and to transfer the engineering classes of the latter to its care. If any Japanese institution may be said to be British, the Engineering College may be said to be so from its foundation until the present moment. Its Chairs have all been held by English men of science, and are still held by them.

THE administration of the Ethnological Section of the Royal Museum at Berlin has commenced the publication of a periodical having for its object the description of the contents and additions to the collection. It is published by Spemann of Berlin. The first number contains an account of Dr. Nachtigal's ethnological collections, of those from Easter Island, a description of the burials of the Pelew Islands by Herr Kubary, also one of the ourney of the collector, Herr Rohde, in Matto Grosso and the Indian tribes of this region. Dr. Grube describes a collection of Taoist pictures; Dr. Grünwedel contributes notices of the iconography of the Lamas of Tibet and Mongolia, and Bishop Thiel supplies a vocabulary from Costa Rica. Some of the papers are illustrated by plates.

THE Christiania University has received a valuable collection of ethnographical objects from East Greenland from the Danish Government, as a mark of appreciation of the services rendered by Dr. Knutsen, a Norwegian naturalist, to the expedition under Lieut. Holm, of which he was a member.

THE well-known Norwegian *savant*, Dr. Rausch, makes in the Norwegian press an appeal respecting meteors and earthquakes which is not without interest. Respecting the former, he points out the scientific value of these objects, and describes their outward appearance when reaching the earth, with a request that a better look-out may be kept by people than has hitherto been the case. Only two meteorites have hitherto been found in Norway, viz. one in 1848 and one in 1884. Dr. Rausch is, however, of opinion that a great many more have fallen. Respecting the belief prevalent among the peasants that a stroke of lightning is preceded by a stone, said to be dark and burnt in appearance, the so-called "Thorelo," *i.e.* "Thor's wadding," and which are kept on farms as a kind of "household medicine," he ventures to suggest that they are meteorites, and begs those who may possess such to send him a small sample of the same. With regard to earthquakes he begs that a closer attention be given to their duration, extent, and the exact number of shocks, &c., than has hitherto been the case, remarking that only the most minute details will enable us to discover the origin and laws of these important phenomena.

A LETTER from Bagamoyo, published in *Cosmos*, describes a shower of stars seen there on November 27 last year. There were at the time neither moon nor clouds; the firmament was of a sombre blue. The phenomenon commenced at 7 o'clock, and the writer watched it until 9. Again he observed it at 11, and he was informed that it lasted all night. Bagamoyo is situated at 6° 23′ south, and 36° 30′ east of the meridian of Paris. Putting the average fall at eight per second, which he believes to be below the actual number, the number for the twelve hours of the night would be about 350,000 asteroids. They came from all points of the heavens, but they appeared to increase sensibly as one ascended from the horizon towards the zenith. Usually they fell singly, but sometimes a single constellation of five, eight, and ten at a time fell. Their luminous course was uniformly directed towards the south, south-east, and south-west. They did not appear to form curves, but rather to advance rapidly in straight lines. Many were like ordinary shooting-stars, but others left behind them a luminous trail of extraordinary vividness and beauty. White was the commonest colour in the train, but many had a red, yellow, and orange tint. Each lasted about a second, but some persisted for five and even ten seconds. No sound or smoke was perceived, and the phenomenon was followed by no notable change in the atmosphere. Two days after some thunder was heard and a few drops of rain fell. It is noted as curious that an old wise man on the coast had predicted shortly before that fire would fall from heaven shortly; possibly he had recognised a certain periodicity in the shower.

WE have received the first part of vol. i. of the *Annalen* of the Imperial Natural History Museum of Vienna, edited by the Director, Baron von Hauer. This part contains an account of the year's work of the Institution, the organisation of which and the arrangement of the new buildings were described in a recent number of NATURE. As the Museum includes all departments of natural history in its widest sense—geology, zoology, botany, anthropology—it will be evident that the year's work will be full of interest. This part is the first of what promises to be a series of papers issued at frequent intervals. In the next number will be papers on new species of fish from the Orinoco and Amazon, by Dr. Steindachner; on new and rare antelopes in the Museum, by Dr. Kohl; and on the flora of South Bosnia and neighbouring regions, by Dr. G. Beck.

WE referred in a previous number to ova having been artificially spawned from sea-trout, *S. trutta*, at the South Kensington Aquarium, which had been retained in captivity for three years, and had therefore not visited the sea. The ova have since become incubated, and the fry, which are hybrids, appear to be in a healthy state. The mortality amongst them is heavier than with those produced from ordinary fish, especially at the period when emerging from their shell. There is an abnormal number of monstrosities amongst them, which never live beyond a few days. The ova produced from fish in captivity occupy a longer time in hatching out than those spawned from wild fish. Owing to the severity of the weather this season, hatching operations have been greatly retarded, but the fry seem to be more vigorous and healthy in consequence.

To show the value attached to the *S. fontinalis*, or brook-trout of America, when first introduced into this country some few years since, it may be mentioned that, according to the price-lists issued by pisciculturists at the time, 100*l*. per thousand was charged for them. The same amount was mentioned for whitefish, which, until last year, were not successfully acclimatised to our waters. The price charged at the present day for the same fish is about 2*l*. per thousand.

DR. J. P. LICHERDOPOL writes under date February 23 from Bucharest (Roumania):—"Yesterday at 3.40 p.m. a slight shock of earthquake was noticed here, followed by two others strong enough to make objects hung on the walls move. Atmosphere calm, but covered with fog. No damage."

THE telephone system of Stockholm is developing rapidly: on January 15 it had 3164 subscribers, against 2335 in the beginning of 1885, and 865 in the previous year. Last year there were over 4½ million communications, of which 85,000 were by night. The subscription is about 7*l*. a year. Stockholm is connected by telephone with several neighbouring towns, the furthest being Trosa, 50 miles distant.

AT a recent meeting of the Paris Medico-Psychological Society, M. Rey (who was intrusted with documents, &c., left by Broca) gave the results of 347 observations by that eminent man on the weight of the three cerebral regions (*a*) the frontal lobes, (*b*) the occipital lobes, and (*c*) the parietal regions. In men the ratio of these parts to the brain is (*a*) 1 : 2·33, (*b*) 1 : 10·66, (*c*) 1 : 2·12. In females (*a*) 1 : 2·32, (*b*) 1 : 9·88, (*c*) 1 : 2·13. In men the left frontal lobe has more weight than the right; but the difference between the two diminishes with the weight of the whole organ. In the case of the occipital lobes and the temporal regions the right side preponderates over the left. In old men the loss of weight in the parieto-frontal regions is more sensible than that in the frontal and occipital lobes. It is still more pronounced in women; so that, while in adult age men have proportionally more in the frontal lobes, this proportion is reached by women in old age. In men the frontal lobes only attain their greatest weight at 35 years of age; but at 25 the parieto-temporal regions have their maximum weight. In women, with regard to the anterior lobes, there is little difference between 25 and 35 years of age.

MR. VAN VOORST has in the press and will very soon publish a new and enlarged edition of Prof. Mills' "Manualette" of the destructive distillation of petroleum, rosin oil, coal-tar, and kindred industries, with illustrations of shale retorts.

THE February number of *Petermann's Mittheilungen* contains a paper by Dr. Andries on the causes of the increasing number of accidents by lightning. As to the fact of the increase itself, he shows from statistics that this has, in the last fifty years, been three- to five-fold. In Bavaria the proportion is 1 to 5, and between 1854 and 1877 it has risen from 1 to 2·75 for all Germany. The question now is: Whence arises this striking increase? Various hypotheses have been advanced to accoun for it. Bezold refers it to varying maximum and minimum periods, the present being one of the former; Karsten attributes it to the decrease of forests, which made houses more and more the prominent points of a neighbourhood; others again allege the increase of lofty buildings, factories, and such like as the cause. Dr. Andries observes that although these may account for some of the increase, they cannot do so for all. Nor do they adequately explain the enormous and sudden increase in such a short period. He states the problem thus: "How can the electrical tension during thunderstorms be so increased that a greater number of bolts strike the earth than formerly? For it is not so much the increasing number of storms as their increased violence that causes the accidents by lightning." The main cause is said by him to be the enormous increase in the last half century in manufactories, locomotives, &c., filling the air with smoke, steam, and particles of dust of all kinds, the increase of population adding likewise to the impurity of the atmosphere. Having arrived at this point, viz. the enormous increase of foreign particles in the atmosphere, and their wide distribution by various currents of air, Dr. Andries describes at some length experiments made by himself and others on the subject, which showed that all the electrical phenomena of the air increased in intensity with the increase of dust in it, and to the same cause he attributes the increased appearances of the aurora borealis. Accidents by lightning in the southern half of the globe should, if this be correct, be much less frequent than in the other half; and this, he says, really appears to be the case. At any rate, he thinks, the southern lights are not visible nearly so frequently as those of the north.

THE additions to the Zoological Society's Gardens during the past week include eight Viscachas (*Lagostomus trichodactylus*) from Buenos Ayres, presented by Mr. E. Vere Dashwood; four American Hares (*Lepus americanus*) from North America, presented by Mr. F. J. Thompson; six Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by the Hon. Sir Julius Vogel, K.C.M.G.; a Macaque Monkey (*Macacus cynomolgus*) from India, fifteen Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, deposited; two Yucatan Blue Jays (*Cyanocitta yucatanica*) from Yucatan, two Great Barbets (*Megalæma virens*) from the Himalayas, purchased; a Red Kangaroo (*Macropus rufus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR γ CORONÆ AUSTRALIS.—Mr. J. E. Gore has recently computed elements of the orbit of this binary, fixing the periastron passage at 1886·53 and the period at 81·78 years. These elements differ widely from those deduced three or four years ago by Mr. Downing, who, by determining corrections to Prof. Schiaparelli's orbit, from a considerably larger number of observations than have been utilised by Mr. Gore, found the epoch of periastron passage to be 1883·203 with a period of 54·985 years. The position-angles computed from these two sets of elements now differ enormously, as is seen from the following tabular statement:—

Epoch		Angle		Distance	Computer
		°		″	
1886·0	...	51·3	...	1·28	Downing
1886·53	...	48·5	...	1·44	
1886·0	...	200·7	...	1·20	Gore
1886·53	...	196·7	...	1.13	

We venture to express the hope that those astronomers who can observe this object will not fail to do so in the present interesting stage of its physical history.

THE NEBULA ROUND MAIA.—Prof. E. C. Pickering states, in the *Astron. Nach.*, No. 2712, that the announcement of the discovery of the nebula near Maia by means of photography recalled to him the circumstance that certain peculiarities had been noticed in a photograph of the Pleiades taken at Harvard College Observatory on November 3, 1885. These were supposed at the time to be merely photographic defects, but it now appears that one of the markings corresponds to the Maia nebula. The other irregularities seem to afford indications of the Merope nebula. There is also a faint narrow streak of light projecting from Electra on the following side.

PROF. LANGLEY ON THE EMISSION-SPECTRA OF BODIES AT LOW TEMPERATURES.—Prof. Langley having traced the solar spectrum in the infra-red so far as $\lambda = 0·0027$mm., where it suddenly ceased, has since examined the emission-spectra of various terrestrial substances at temperatures from that of fusing platinum to that of melting ice, and more particularly of temperatures corresponding to the ordinary conditions of the soil. The result of his observations has been to show that the maximum of heat from cold and black bodies has in every case a wave-length greater than 0·0027mm.,—greater, that is to say, than that of the lowest solar heat which reaches us; and that further, that part of these spectra which has a greater wave-length than that of the point of maximum, represents a larger total amount of heat than the part with shorter wave-length. Prof. Langley believes that he has been able, by means of his bolometer, to trace out the emission-spectra of cold bodies so far as $\lambda = 0·0150$mm., a wave-length more than twenty times as great as that which Newton found for the lower limit of the spectrum, viz. $\lambda = 0·0007$mm.

FABRY'S COMET.—Dr. H. Oppenheim has computed the following fresh elements and ephemeris for this comet:—

T = 1886 April 5·5398 Berlin Mean Time

$$\left.\begin{aligned}\omega &= 126^\circ\ 50'\ 27''·6\\ \Omega &= 36\ 19\ 54·0\\ i &= 82\ 11\ 15·0\end{aligned}\right\}\ 1886·0.$$
$$\log q = 9·804021$$

Ephemeris for Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log. r	Log. Δ	Brightness
March 7	23 19 34	31 19·6 N.	9·9441	0·1621	8
11	23 18 54	32 29·8	9·9171	0·1424	10
15	23 18 11	33 42·0	9·8904	0·1191	12
19	23 17 29	34 54·6 N.	9 8650	0·0916	16

The brightness on December 2 is taken as unity.

BARNARD'S COMET.—The following ephemeris by Dr. A. Krueger is in continuation of that given in NATURE for February 18, p. 376:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log. r	Log. Δ	Brightness
March 6	1 54 54	22 35·8 N.	0·1229	0·2415	4·10
10	1 53 55	23 45·9	0·1001	0·2390	4·61
14	1 53 6	24 58·9	0·0757	0·2352	5·25
18	1 52 26	26 14·9 N.	0·0497	0·2299	6·07

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *MARCH* 7-13

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 7

Sun rises, 6h. 34m.; souths, 12h. 11m. 10·0s.; sets, 17h. 48m.; decl. on meridian, 5° 11′ S.: Sidereal Time at Sunset, 4h. 49m.

Moon (two days after New) rises, 7h. 16m.; souths, 13h. 21m.; sets, 19h. 36m.; decl. on meridian, 0° 28′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 54	12 49	18 44	1 47 S.
Venus	5 1	10 30	15 59	6 48 S.
Mars	17 23*	0 15	7 7	9 24 N.
Jupiter	19 10*	1 15	7 20	0 16 N.
Saturn	10 54	19 5	3 16*	22 46 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
8	B.A.C. 408	6½	18 11	near approach	54 —
9	64 Ceti	6	17 31	18 38	118 342
9	ξ Ceti	4½	18 35	19 39	156 310
13	130 Tauri	6	16 49	18 1	91 253

Saturn, March 7.—Outer major axis of outer ring 43″·0; outer minor axis of outer ring 19″·3; southern surface visible.

March	h.	
10	2	Venus stationary.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
T Cassiopeiæ	0 17·1	55 10 N.	Mar. 10,	0 0	*m*
U Cephei	0 52·2	81 16 N.	,, 8,	20 36	*m*
			,,	20 16	*m*
V Tauri	4 45·4	9 42 N.	,, 12,		*M*
ζ Geminorum	6 57·4	20 44 N.	,, 10,	0 0	*m*
δ Libræ	14 54·9	8 4 S.	,, 11,	22 10	*m*
R Coronæ	15 43·9	28 30 N.	,, 12,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 9,	2 22	*m*
			,, 9,	22 30	*m*
X Sagittarii	17 40·4	27 47 S.	,, 10,	0 0	*m*
			,, 12,	21 30	*M*
U Sagittarii	18 25·2	19 12 S.	,, 9,	22 30	*m*
			,, 12,	22 30	*M*
S Vulpeculæ	19 43·7	27 0 N.	,, 11,		*m*
η Aquilæ	19 46·7	0 7 N.	,, 8,	4 50	*m*
S Aquilæ	20 6·4	15 17 N.	,, 13,		*m*
δ Cephei	22 24·9	57 50 N.	,, 12,	2 30	*m*

M signifies maximum; *m* minimum.

Meteor Showers

Two showers may be looked for on March 7, viz. near γ Libræ, R.A. 233°, Decl. 18° S.; and near γ Herculis, R.A. 244°, Decl. 15° N. Other showers of the week:—Near ε Cassiopeiæ, R.A. 36°, Decl. 67° N.; from Virgo, R.A. 190°, Decl. 1° N.; from Cepheus, R.A. 300°, Decl. 80° N.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
124 Schjellerup	9 45 48	22 29·0 S.	IV.
132 Schjellerup	10 31 54	12 47·6 S.	IV.
D.M. +68° 617	10 37 9	68 0·6 N.	IV.
136 Schjellerup	10 46 5	20 38·8 S.	IV.
56 Leonis	10 50 5	6 47·7 N.	III.
R Crateris	10 54 58	17 42·8 S.	III.
ω Virginis	11 32 35	8 45·9 N.	III.
145 Schjellerup	12 19 24	1 24·1 N.	IV.
152 Schjellerup	12 39 46	46 3·8 N.	IV.
155*b* Schjellerup	12 51 57	66 36·6 N.	IV.
40 Comæ Ber.	13 0 49	23 13·8 N.	III.

THE SUN AND STARS[1]

II.

First Conclusions

THE view of the solar constitution, which was based upon the early work to which I have referred—work which dates from about the year 1860, and is therefore about a quarter of a century old—the view which grouped together, and endeavoured to make a complete story of all the facts which were known then, was this: the chemical substances which had been found to exist in the sun's atmosphere existed quite close—relatively quite close at all events—to the photosphere. When subsequent work demonstrated the existence of hydrogen to a considerable height above this photospheric envelope, as I shall show presently, the idea was suggested that these chemical substances existed in the atmosphere, not pell-mell, not without order, because Nature is always full of the most exquisite order, but in the sequence of their vapour-densities, so that a very heavy vapour would be found low down in the atmosphere, and a very light one like hydrogen would be high up.

It was at first suggested that gaseous diffusion would prevent such a sorting out, until it was pointed out by an American mathematician, Prof. Pierce, that it was a good deal to ask that diffusion should act along a radius something like a million of miles long, and indeed he showed that it would not.

Before we go farther, I give tables of the different substances which so far have been traced in the sun's atmosphere by means of their spectral lines. The first gives the substances according to the results obtained by Kirchhoff,

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 403.

Ångström, and Thalèn, who were the first workers in this field of inquiry.

TABLE A.—*Elements present in the Sun according to Kirchhoff, Ångström, and Thalèn*

Kirchhoff	Ångström and Thalèn
Sodium	Sodium
Iron	Iron
Calcium	Calcium
Magnesium	Magnesium
Nickel	Nickel
Barium	—
Copper	—
Zinc	—
	Chromium
	Cobalt
	Hydrogen
	Manganese
	Titanium

Another gives the substances which were added to the preceding list by taking a special consideration into account. Some time after the first work on the chemical composition of the solar atmosphere was accomplished, a method was introduced by which it was easy to determine the existence of a small quantity of any particular vapour in a mixture of vapours, so that the substances indicated in the second table are those substances which possibly exist in the sun's atmosphere in a small quantity only.

TABLE B.—*Elements the Longest Lines of which coincide with Fraunhofer Lines*

Certainly coincident	Probably coincident
Aluminium	Indium
Strontium	Lithium
Lead	Rubidium
Cadmium	Cæsium
Cerium	Bismuth
Uranium	Tin
Potassium	Silver
Vanadium	Glucinum
Palladium	Lanthanum
Molybdenum	Yttrium or Erbium

It is important to call special attention to the fact that Ångström and Thalèn, who followed Kirchhoff, did not agree with regard to barium, or copper, or zinc, and they added chromium, cobalt, hydrogen (a very notable addition), manganese, and titanium, the existence of which Kirchhoff had not discovered in the solar atmosphere.

A detailed study of the facts recorded by Ångström gives a good idea of the immense difficulty of the research, and also of the doubts and of the difficulties which were suggested in the very first part of the inquiry. For instance, in the case of sodium, what Ångström did, of course, was to get the vapour of sodium incandescent in the laboratory, and he got the eight familiar lines. He then observed whether there were dark lines corresponding with all of them. He found that there were. With regard to cobalt he got nineteen lines, and he found nineteen lines in the sun coinciding with them. But when he studied the spectrum of barium in his laboratory he got twenty-six lines, but of these in the solar spectrum he found only eleven. When he came to aluminium, of the fourteen lines seen in the spectrum of the metal only two existed among the Fraunhofer lines. In zinc it is not yet quite decided whether we even have two out of twenty-seven; so that we see it was not all perfectly plain sailing.

A New View

So much, then, for the chemistry of the solar atmosphere, taken as a whole. Two observations suggest themselves: the first is, that it is perfectly clear that if we have in the sun's atmosphere incandescent iron vapour, and calcium vapour, and magnesium vapour, and the incandescent vapours of many other substances which we generally know here as solid bodies, there must be tremendously strong convection-currents somewhere; for were these vapours at rest they must cool on the outside, and if they get up high enough they will condense, first into liquid particles, and then into solid particles, and then they are bound to go down. So that we see there is a new world of motion in full front of us the moment we are driven to the conclusion that we are really dealing with a mixed mass of gases so intensely hot that its constituents exist in it, except in the coldest parts of it, in a state of vapour. To enable us to think this out a little, let us consider a small part of the sun where we will imagine that the statical condition is as nearly secured as possible, and that then we suddenly upset the temperature equilibrium. When we get any solid particles, say of iron, falling into a region where they will be gradually melted, and then driven into iron vapour, the vapour is bound to reascend—it will not continue in its downward flight; whereas if vapours, by ascending, gradually get cooler and cooler, they must afterwards redescend, falling first, as I have said before, as mist and then in big liquid drops, and finally as solids—as meteorites, if you like: they are bound to go down. To put this in the most general form, we may say that in the sun's atmosphere complex molecules are bound to go down, and simple molecules are bound to go up; so that we shall have convection-currents, as I have already hinted, produced in this kind of way, and these convection-currents must exist wherever the temperature equilibrium is broken. Of course we must assume that these more or less vertical convection-currents may be modified to a certain extent by the rotation of the sun, in the same way as the up and down currents of our own air, and even the currents pole-wise and equator-wise are modified by the rotation of the earth.

The other observation which suggests itself is as follows:—We need not limit ourselves to the general chemical ideas we have acquired; the chemistry of each part of the sun (always above the photosphere) can be examined bit by bit. The photosphere has spots in it; it has the chromosphere above it with the included prominences, the inner corona above that, the outer corona above all. As a matter of fact, all these have now been examined, bit by bit, by the spectroscope—that is from the chemical point of view.

The next point of importance to urge is that a view of the solar constitution has been arrived at in consequence of this new wealth of facts, on which something must be said before we go further.

The old view put the absorbing atmosphere above the photosphere, the various chemical substances being arranged in the order of their vapour-densities, so that hydrogen would be highest, then sodium, then magnesium, till finally we arrive at iron and platinum, and so on.

Now, if that view were correct, it would be perfectly easy to prove it at once by the new method of local examination. We have only during an eclipse, or even without an eclipse, to put the slit of a spectroscope on the edge of an image of the sun thrown by an object-glass, and observe the spectrum from each part of the sun; from the photosphere to as far above the photosphere as we can get. If that view were true, we should get, as short bright lines close to the photosphere, the lines of substances having a high atomic weight. Then higher and higher we should get longer lines indicating the existence at greater heights in the solar atmosphere of those substances which have a smaller atomic weight. Further, as we have evidence to show that the spots exist in a low part of the sun's atmosphere (how low we shall see by and by, when we come to consider them in detail), we should expect in those spots to find all the familiar lines of the substances having a high atomic weight to be affected. When we examine the chromosphere and the base of the prominences which arise out of it, we should find that at the same height or about the same height where the spots give us lines of the substances of high atomic weight, the chromosphere itself should be full of the same substances of high atomic weight.

Now the fact that not one of these expectations is realised—that none of these things are so—has necessitated the putting forward of the new view to which I have referred.

This can be stated in a very few words. It is that the temperature of the sun is not only sufficient to drive all our most refractory metals into vapour, as we can do in our laboratories on the earth, but that it goes very much further; it continues the work of our laboratories, and drives them into something else altogether finer than anything that we can separate with our terrestrial conditions. According to that view, what would happen would be this:—If we could lay hold of a solar meteorite, say a hundred thousand miles from the photosphere, and watch it in its downward flight, the solid would first become liquid, it would then be vaporised, and we should have the spectrum with which we are familiar in our laboratories; but after that the vapour would still go through a series of simplifications of which we can take no count in our laboratories, because we have not the same temperature. What would happen in that view is that obviously we should know nothing whatever of the spectrum of the lower part of the atmosphere open to our inquiries. Now that is practically the fact. The spectrum of the region just above the photosphere is one of the strangest things in solar physics. Almost everything there is strange. The lines which we see are lines either altogether unknown to us, or are seen without their usual terrestrial companions. Many are found in none of the maps prepared in any of our laboratories, and whether we read this story from the facts presented by spots, or those observed in prominences, we get the same apparently inexplicable riddle.

All this, then, by way of introduction. There will be a good deal to be said as to details in the sequel. What we have next to do is to commence our detailed examination of each portion of the sun.

Description of the General Surface

To do this it is proper that we should begin with that part with which we are most familiar: I mean the photosphere—the bright shining surface which represents to most of us the actual veritable sun.

When we look at the sun by means of an ordinary telescope, taking proper precautions,—it will never do to look straight at the sun with an ordinary telescope unless we wish to be instantly blinded,—what one sees is first a bright disk, which is slightly dimmed at the edge; here and there, it may be, will be seen dark objects, the *spots*, although it may happen that no spots will be visible; on examining the disk carefully, what we further see is a strange mottling of the whole surface. The mottling is very often very delicate; but everywhere, in all parts of the sun, near the poles, near the solar equator, and universally, we get this strange mottling. These fine mottlings sometimes take certain directions, in consequence of the existence of powerful currents. Here and there we get cyclonic swirls, and here and there there is an appearance of smudginess, apparently produced by tremendous overhead currents, so to speak, that is, currents between us and that part of the sun on which they appear.

Some photographs of the sun taken of late years by Dr. Janssen at the Physical Observatory at Meudon, near Paris, have thrown great light upon the general arrangement of this mottling.

An attentive examination of his photographs shows that the surface of the photosphere has not a constitution uniform in all its parts, but that it is divided into a series of figures more or less distant from each other, and presenting a peculiar constitution. These figures have contours more or less rounded, often very rectilinear, and generally resembling polygons. The dimensions of these figures are very variable; they sometimes attain a minute and more in diameter.

While in the interior of the figures of which we speak the grains are clear, distinctly terminated, although of very variable size, in the boundary the grains are as if half effaced, stretched, strained; for the most, indeed, they have disappeared to make way for trains of matter which have replaced the granulation. Everything indicates that in these spaces, as in the penumbræ of spots, as we shall see, the photospheric matter is submitted to violent movements which have confused the granular elements.

In these investigations the sun's appearance can be better studied by these photographs than by means of the eye and telescope. This is what Dr. Janssen says on this point:—

"The photospheric network cannot be discovered by optical means applied directly to the sun. In fact, to ascertain it from the plate, it is necessary to employ glasses which enable us to embrace a certain extent of the photographic image. Then, if the magnifying power is quite suitable, if the proof is quite pure, and especially if it has received rigorously the proper exposure, it will be seen that the granulation has not everywhere the same distinctness; that the parts consisting of well-formed grains appear as currents which circulate so as to circumscribe spaces where the phenomena present the aspect we have described. But to establish this fact it is necessary to embrace a considerable portion of the solar disk, and it is this which it is impossible to realise when we look at the sun in a very powerful instrument, the field of which is, by the very fact of its power, very small. In these conditions we may very easily conclude that there exist portions where the granulation ceases to be distinct or even visible; but it is impossible to suppose that this fact is connected with a general system."

Independently, then, of the phenomena of spots (about which presently), the verdict of minute examination is that the whole photosphere is riddled by convection-currents; because I shall have to show that each of those dark markings which we will call *pores*, is the seat of a downrush, and each of those *domes*, as we will call the intervening brighter portions, is, in all probability, a dome produced by the very same cause that gives us the grand domes of our cumulus clouds on a summer's day.

The Cause of the Photosphere

In discussing any subject, especially such a subject as the sun, it does not do to avoid difficulties, and therefore I may very frankly say that one of the greatest difficulties which students of solar physics have met with up to the present time has been the absence of an easy and satisfactory way of explaining the existence, and the sharp boundary, and the intense brilliancy of the photosphere.

The photosphere, as already stated, is about 400,000 miles—in round numbers—from the sun's centre. If we take the average density of the sun at a pretty low figure, as we found reason to do in the last lecture, we note that the photosphere, assuming it to be a shell, exists in a region of low pressure, and we see in a moment that, unless we suppose the photosphere, or something immediately inside the photosphere, to be solid, there is no reason for supposing any very great increase of pressure at the photosphere itself. In fact, there are a great many reasons for regarding this as improbable, not to say impossible.

Now, if that is so, we are driven to another line of inquiry, and it is this. If there can be no sudden increase of pressure at the photospheric level to account for the sudden luminosity, to what other cause must we look? Driven to our supports, it is fair to ask whether any sudden increase of temperature will help us?

In an ordinary gas-jet we have coal-gas burning. When we examine the coal-gas flame in an ordinary fish-tail burner, with the spectroscope, what we find is this: Up to the part where the luminosity—the white light—suddenly begins, about half-way up, we get the flutings of acetylene and marsh-gas, and above that we get nothing whatever except a continuous spectrum; therefore, according to the books, we have now either a solid, or a liquid, or a densely gaseous substance to deal with. That is an obvious suggestion, and one apparently in harmony with all the facts. I think that is the general opinion now. Hence in a flame, in the non-luminous portion, we have got hydrocarbons ascending. So long as they are not dissociated they are feebly luminous. The light which they give is chiefly a fluted light, by which I mean that if we observe it with the spectroscope we do not get much continuous spectrum. When the hydrocarbons reach a certain height in the flame, their dissociation becomes possible, the solid particles of carbon are set free; these solid particles of carbon when free give a continuous spectrum totally different from that which they gave when they were associated with the hydrogen in its various proportions in the lower part of the flame.

Now, it is obvious that, generally, everything above the photosphere must be cooler than the photosphere itself. Have we then a relatively non-luminous gas going down, which at a distance of 430,000 miles from the sun's centre finds a region where chemical combination is destroyed, the effect being exactly the same—different in degree, but not different in kind—from that which we watch in a candle or gas-flame, imagining the gas-flame to be inverted for the sake of simplicity? That is the question. Is it along such a line as this one is to look for the solution of the mystery of the sudden brightening of the photosphere, rather than along that other one which attributes the increase of brilliancy to the sudden increase of pressure, for which really one sees no physical basis at all?

The Faculæ

It was stated that the pores were supposed to be the seats of downrushes, and that the domes between the pores were the equivalents of our cumulus clouds.

The brighter portions of the photosphere, called *faculæ*, consist of domes heaped up together, or arranged in certain directions. We shall find by and by that they are associated with a certain stage in the history of every spot. But they are by no means limited to the vicinity of spots. We may have some development of these faculæ in parts of the sun where there are no spots at all.

Those who are familiar with this class of observations will remember that it is much easier to see the faculæ near the sun's limb than in the centre of the sun. Also it is easier to get a photograph of the faculæ using a collodion or a dry plate which works very far up in the blue, than it is with a collodion or a dry plate which works in the green or the blue-green; this latter fact proves to us quite conclusively, as it was pointed out a good many years ago now,[1] that the difference between the light at the top of a dome, so to speak, or the bottom, or between the top of the cumulus and the base of the pore, is a difference chiefly of that kind of light which writes its record by means of the absorption of the blue end of the spectrum.

The reason that we see the sun red at sunrise and sunset frequently is not that there is anything different in our air at that moment, but because we are looking at the sun through a greater thickness of the air; and the redness of the sun is the balance left after our atmosphere has done all it can in the way of absorbing the blue. We do not expect to get the sun red at midday. Of course a London fog will do anything; but I am talking of our ordinary atmosphere; and the fact that we do not get the sun red in the middle of the day is one of the same kind as the other one that we do not so easily see the faculæ on the centre of the sun as we do at the edge of it. There is absorption going on between the top of a facula and the bottom of a pore; and, as you know, to get that out in its greatest vigour and quantity we must take the greatest possible thickness of atmosphere. We see in a moment that the only way to have a considerable thickness of solar atmosphere to work this for is to make observations near the sun's limb.

These faculæ exist on an enormous scale. It is quite common to see reaches of them tens of thousands of miles long, lasting for days, and perhaps weeks; we get in that fact an indication of the enormous amount of energy which may still be changing places in the solar atmosphere, even though we do not get other phenomena which appear to us to be more important. By "other phenomena" of course I mean the spots.

J. NORMAN LOCKYER

(*To be continued.*)

[1] In 1872; see "Solar Physics," p. 404.

BARK BREAD

MOST travellers in Norway have probably had more than sufficient opportunities of becoming acquainted with the so-called "Fladbröd," flat bread, of the country. Few, however, among them who have partaken of this dry and insipid food may possibly be aware that in many districts, more especially in Hardanger, the chief ingredient in its composition is the bark of trees. This substitution of an indigestible product for *bonâ fide* flour is not necessarily a proof of the scarcity of cereals, but is to be ascribed rather to an opinion prevalent among the peasant women that the bark of young pine branches, or twigs of the elm, are capable of being made into a thinner paste than unadulterated barley or rye-meal, of which the Norse housewife, who prides herself on the lightness of her "Fladbröd," puts in only enough to make the compound hold together.

The absence of any nutritive property in bark bread, whether made with elm or pine bark, and the positive injury it may do the digestive organs, has of late attracted much notice among Norwegian physiologists, and the editor of *Naturen*, with a view of calling the attention of the public to the subject, has, with the author's permission, reprinted some remarks by Dr. Schübeler on the history and character of the bark bread of Scandinavia. From this source we learn that the oldest reference to the use of bark bread in Norway occurs in a poem, ascribed to the Skald Sighvat, who lived in the first half of the eleventh century. In the year 1300 the annals of Gothland record a season of dearth, in which men were forced to eat the bark and leaf-buds of trees, while then, and during the later periods of the Middle Ages, the frequent failure of the crops in all parts of Scandinavia led to the systematic use of the bones and roe of fishes, as well as the bark of trees as a substitute for genuine flour; and so extensively was the latter substance used that Pastor Herman Ruge, who in 1762 wrote a treatise on the preservation of woods, has drawn attention to the almost complete disappearance of the elm in the Bohus district, which he ascribes to the universal practice in bygone times of stripping the bark for the preparation of bread.

In Nordland and Finmark the root of *Struthiopteris germanica* and other ferns, as well as the leaves of various species of Rumex, have been largely used with barley-meal in making ordinary bread as well as "Fladbröd." In Finland the national "pettuleipa" (bark bread), which was in former times almost the only breadstuff of the country, still ranks as an ordinary article of food in Kajana, and in the forest-regions of Oesterbotten, and Tavastland. Here it is usually made of the inner layers of the pine-bark, ground to a meal, which is mixed with a small quantity of rye-flour to give the requisite tenacity to the dough. The Finlanders of an older generation showed marvellous ingenuity in composing breadstuffs, in which scarcely a trace of any cereal could be detected in the mixture of bark, berries, seeds, bulbs, and roots of wild plants, which they seem to have accepted as a perfectly legitimate substitute for corn-bread. In the interior of Sweden, according to Prof. Säve, the *best* bread of the peasants consisted till the middle of this century of pease, oats, and barley-meal in equal proportions, while in the ordinary daily bread the husks, chaff, and spikes of the oats were all ground down together. In bad seasons even this was unattainable by the Dalekarlian labourer, who had to content himself with pine-bark bread.

DILATANCY[1]

THE principal object of this lecture was to show experimental evidence of a hitherto unrecognised fact of fundamental importance in mechanical philosophy. This newly-recognised property peculiar to granular masses (named by the author "Dilatancy") would be rendered clear by the experiments. But it was not from these experiments that it had been discovered. This discovery was the result of an endeavour to conceive the mechanical properties a medium must possess in order to act the part of the all-pervading ether—transmitting waves such as light, but not such as sound, allowing free motion of bodies, causing distant bodies to gravitate, and causing forces like cohesion, elasticity, and friction between adjacent molecules, together with electricity and magnetism.

As the result of this endeavour, it appeared that the simplest conceivable medium, a mass of rigid granules in contact with each other, would answer not only one but all of these requirements, provided such shape or fit could be given to the grains that, while these rigidly preserved their shape, the medium should possess the apparently paradoxical or anti-sponge-like property of swelling in bulk when its shape was altered.

This required that the grains should so interlock that, when any change in the shape of the mass occurred, the interstices between the grains should increase. Having recognised this property as a necessity of the ether, the next question became, What must be the shape and fit of the grains so that the mass might possess this unique property? At first it seemed that there must be something special and intricate in this structure. It would obviously be possessed by grains shaped to fit into each other's interstices: this was illustrated by a model of bricks arranged to bond as in a wall; when the pile was distorted, interstices appeared. Subsequent consideration revealed this striking fact—that any shape of grains resulted in a medium possessing this property of dilatancy so long as the medium was continuous, or so long as precautions were taken to prevent rearrangement of the grains, commencing at the outside. All that was wanted was a mass of smooth hard grains, each grain being held by the adjacent grains, and the grains on the outside being so controlled as to prevent rearrangement. This was illustrated by a model of a pile of shot, which, when in closest order, could not have its shape changed without opening the order and increasing the interstices. The pile being brought from closest to most open order by simply distorting its shape, the outside balls being forced, those in the interior were constrained to follow, showing that in no case could a rearrangement start in the interior.

Considering the generality of this conclusion, it was necessary to explain how it was that dilatancy was not a property of ordinary atomic or molecular matter. This was owing to the elasticity, cohesion, and friction which rendered molecules in-

[1] Abstract of a Lecture delivered at the Royal Institution of Great Britain, on Friday evening, February 12, 1886. By Prof. Osborne Reynolds, LL.D., F.R.S.

capable of acting the part of independent grains whose only property was to keep their shape. This was not inconsistent with dilatancy in ether, for these physical properties were possessed by the molecules of matter in consequence of the presence of the ether, and hence it was not logical that the atoms of ether should possess these properties.

If evidence of dilatancy were to be obtained from tangible matter, it was to be sought on the most commonplace, and what had hitherto been the least interesting, form, that of hard, separate grains—corn, sand, shot, &c.

That an important geometrical and mechanical property of a material system should have lain hid for thousands of years, even in sand and corn, was such a striking thought that it required no small faith in mechanical principles to undertake the search for it; and, though finding nothing but what was in accordance with previous conclusions, the evidence obtained of this long-hidden property was as much a matter of surprise to the lecturer as it could be to any of the audience.

To render the dilatancy of a mass of grains evident, it was necessary to accomplish two things: (1) the outside grains must be controlled so that they could not rearrange, and this without preventing change of shape or change of bulk; (2) it was necessary to adopt means of measuring the change of bulk or volume of the mass or of the interstices between the grains as its shape was changed. A very simple means—a thin india-rubber bag—was found to answer both these purposes to perfection. The outside grains indented themselves into the india-rubber, which prevented their changing their places, while the impervious character of the bag allowed of a continuous measure of the volume of its contents by measuring the quantity of air or water necessary to fill the interstices.

In these experiments neither the bag nor the fluid had anything to do with the dilatancy of the contents considered as forming part of a continuous medium, the bag merely controlling the outside members as they would be controlled by the surrounding grains, and the fluid merely measuring or limiting the volume.

India-rubber football cases were then shown full of dry sand, shot, corn, and glass marbles, shaken down into their densest form. The bags could not be distorted, as by squeezing between two plates, without enlarging the interstices between the grains, and hence the volume of the bag. Such increase of bulk was not, owing to the change of shape, evident to the eye; but by connecting the mouth of the bag to a pressure-gauge, it appeared as the squeezing began, the pressure of the air within the interstices began to diminish, and as the squeezing went on diminished as much as 6 inches of mercury, which showed that the interstices had increased a third. These experiments were introduced mainly to prevent the impression that the character of the fluid within the interstices had anything to do with dilatancy. Water affords a more definite measure of volume than air. This was shown. A bag holding six pints of sand full of water without air, connected by a tube with the bottom of a vessel of water, drew, on being squeezed, about a pint of water frnm the vessel into the bag. This was the maximum dilation; for further squeezing the water ran back into the vessel, and then again, for still further squeezing, was drawn back again, showing that, as the change of form proceeded, the medium passed through maximum and minimum dilations.

The most striking evidence of dilatancy is obtained from the fact that, since dilatant material cannot change its shape without increasing in volume, by preventing change of volume all change of shape is prevented. By closing the communication between the bag and the vessel of water, and thus preventing further increase of volume, further change of shape was instantly prevented. Starting with the sand at its densest, and the communication closed, a pinch of 200 lbs. was put on the planes without producing the smallest apparent change in the spherical shape of the bag.

Communication with the pressure-gauge was then opened, which showed that, so far from the water in the bag being at a greater pressure than the atmosphere, it was less by 20 inches of mercury, so that a little more pressure on the planes and a vacuum would have been formed. On opening communication with the water the bag instantly responded by change of shape, and again instantly stopped when the supply was cut off.

That the thickness of the envelope was of no importance so long as it was impervious to air, was shown by using india-rubber ba oons, so thin that the sand could be seen through them; one of these, which was soft and yielding when the water was in excess, became hard like a cannon-ball when the excess of water was drawn off, maintaining any shape it had when the bag was closed, supporting 200 lbs.

In this way a cast was taken from a mould, into which the bag was shaken with water in excess till it took the form of the mould; the excess of water was then drawn off, and the mould removed, leaving an image which preserved its shape loaded with 200 lbs.

The firmness and softness of the sand by the sea was shown to be due to these causes; as the tide falls it leaves the sand apparently dry, but in reality full of water, the surface of which is kept up to the surface of the fine sand by capillary attraction. This saturated sand cannot yield to the tread without dilating, and cannot dilate until it has had time to draw more water, the first effect of the foot being to draw down the capillary surface, leaving the sand apparently dry round the foot. This was shown by experiment.

The lecturer then indicated how the property of dilatancy in a continuous medium would render it capable of causing an attraction between bodies at a distance, like gravitation, and cohesion, and elastic forces between bodies close together; how the ability of the grains to rearrange at a free surface would allow bodies to move freely in the medium which, if in a state of agitation by transverse waves in all directions, would transmit waves like those of light, but not like sound, and which if consisting of grains of two different sizes or shape, would give rise to phenomena resembling those of electricity.

In conclusion, it was remarked that, promising as this dilatant hypothesis of ether was, it could not be taken as proved until it had been worked out in detail. This would take long, and in the meantime it was put forward to add interest to the property of dilatancy, to the discovery of which it had led. The property of dilatancy once recognised was, however, independent of any hypothesis, and seemed to have opened up a new field for philosophical and mathematical research quite independent of the ether.

SOCIETIES AND ACADEMIES

London

Royal Microscopical Society, February 10.—The President, Rev. Dr. Dallinger, F.R.S., in the chair.—The President referred to the loss sustained by the death of Mr. P. H. Lealand, to whom microscopists were so largely indebted for the optica productions which were so well known and appreciated.—The Report of the Council was read and adopted.—Dr. Dallinger then gave his annual address, in which he detailed the results of his later researches into the life-history of minute septic organisms as carried on by means of the improved lenses constructed for him by Messrs. Powell and Lealand. Four forms were selected for study. Each of these septic organisms terminate a long series of fissions with what is practically a generative act of fusion. The two last of a long chain of self-divided forms fuse into one, become quite still, and at length the investing sac bursts, and a countless host of germs is poured forth. The growth of these germs into forms like the parent was continuously watched, showing gradual enlargement, and ultimate, but as to time somewhat uncertain, appearance of the nucleus, and the somewhat sudden appearance of the flagella or thread-like motor organs, the latter being found in each instance to arise in the nucleus. Very soon after the adult stage is reached the act of self-division commences, and is kept up for hours in succession. The delicate plexus-like structure becomes aggregated at one end of the nucleus, leaving the rest perfectly clear, except that a faint beading is seen in the middle line, with two or three finer threads from it to the plexus. Then occurs the commencement of partition of the nucleus, followed by a slight indication of division of the body-substance. Quickly afterwards the nucleus becomes completely cleft, and the body-substance follows suit. Then the plexus-like condition is again diffused equally over the whole nucleus. When the generative condition is approached by the last generation of a long series of dividing forms, it is remarkable that the organism becomes amœboid, showing how far-reaching is the amœboid state. In this condition, when two such forms touch one another they coalesce and fuse into each other almost as though two globules of mercury had touched, until nucleus reaches nucleus and the two melt into one, and the blended bodies become a globular sac, which ultimately emits an enormous number of germs. Previous to the blending it is now made out that all traces of plexus-like structure are lost in the nucleus, which becomes greatly enlarged and assumes a milky aspect, and shows no trace of structure throughout the process of fusion. Afterwards it begins to diffuse itself radially through the body-sarcode, until every trace of the nucleus is gone, and the still globule of living matter becomes tight and glossy, but no trace of structure can be anywhere found in it. In this condition it remains for six hours, when it emits the multitude of germs. After giving similar details about several other organisms, Dr. Dallinger summed up thus:—"One thing appears clear; the nucleus is the centre of all the higher activities in these organisms. The germ itself appears to be but an undeveloped nucleus, and when that nucleus has attained its full dimensions there is a pause in growth, in order that its internal development may be accomplished. It becomes practically indisputable that the body-sarcode is, so to speak, a secretion, a vital product of the nucleus. From it the flagella originally arise; by it the act of fission is initiated and in all probability carried to the end; the same is the case with fertilisation and the production of germs. We are thus brought into close relation with the behaviour of the nucleus in the simplest condition. No doubt far profounder and subtler changes are concurrently proceeding. We of course are no nearer to the solution of what life is. But to come any distance nearer to a knowledge of how the most living part of the minutest organisms acts in detail has for me, and for most biologists, an increasing fascination." The address was illustrated by the aid of the oxy-hydrogen lantern.—The new Council was elected, Dr. Dallinger being elected President for a third term.

BIRMINGHAM

Philosophical Society, February 11.—On Resistance at surfaces of electrodes in electrolytic cells, by G. Gore, LL.D., F.R.S. This paper is a purely experimental one, and contains new proofs of some of the chief results of an extensive research on "transfer-resistance," communicated to the Royal Society, March 2, 1885 (*Proc.* Roy. Soc., 1885, No. 236, p. 209). In it the author shows conclusively that the phenomena discovered by him, and to which he applied that term, are not due to polarisation, some kind of electromotive force, or any other form of opposing difference of electric potential, because they still remain when those causes are entirely absent. He selected various cases of voltaic inversion, in which a pair of different metals in an exciting electrolyte produced no difference of electric potential and no voltaic current, and examined them for "resistance" and differences of "resistance" at the immersed surfaces of the two metals. He first tested them by a "bridge" method, and then by a "condenser" one, also described, and gives the results; and in every case he found that the "resistance" still existed, and was different in amount at the two plates. In each case the plates were of equal sizes. He also took several cases in which a pair of plates of the same metal, but of different sizes, were immersed in an exciting electrolyte, a combination which it is well known produces no difference of electric potential and no voltaic current, and tested them similarly, and found abundant evidence of "resistance," different in amount at the two plates in each instance. By the condenser method he also measured the amounts of such "resistance" at the surfaces of the two different metals, of several voltaic elements at their inversion-points, during absence of difference of electric potential, and gives the quantities. He asks: "Is the phenomenon I have discovered really of the nature of ordinary electric conduction-resistance? If it is, its characters will agree with the most essential ones of that influence. It agrees in several important points with that resistance: first, it is not able to produce a current; second, it is usually small with those liquids in which ordinary resistance is small; and third, it is considerably reduced in liquids by rise of temperature, it also, when overcome by current, evolves heat" (*Proc.* Roy. Soc., 1885, No. 236, p. 209; *Phil. Mag.*, vol. xxi. 1886, pp. 130–148). It differs, however, from such resistance in the less important circumstance that it varies in amount with the strength and density of the current; it is also usually much larger in amount than the ordinary conduction-resistance of a short section of the same liquid. "From these various fundamental truths respecting it, 'transfer-resistance' is a retarding influence essentially similar to ordinary conduction-resistance, but modified, increased in amount, and rendered more complex by taking place at the surfaces of mutual contact of two heterogeneous bodies instead of in the mass of a homogeneous substance." He concludes by remarking that "it performs an important part in the action of all voltaic batteries and electrolytic cells," and calls attention to the circumstance that "one important practical application" of it "has been made in the electro-metallurgical purification of copper on the large scale, where a great saving has been effected by arranging the depositing vats in multiple series, and thus diminish the 'transfer-resistance.'" It was in the year 1831 that the first attempt to discover this kind of resistance was made by Fechner.

PARIS

Academy of Sciences, February 22.—M. Jurien de la Gravière, President, in the chair.—Observations of the small planets made with the great meridian instrument of the Paris Observatory during the fourth quarter of the year 1885, communicated by M. Mouchez.—Determination of the elements of refraction: examination of the general geometrical conditions required to be fulfilled in the practical solution of the problem, by M. Lœwy. The question is treated under the three following heads:—(1) Given the positions of two stars, at what time of the day must the conjugated operations be effected in order to attain the greatest variation of refraction? (2) What angle of the double-mirror is most suitable for obtaining this maximum value? (3) What are the co-ordinates of the two stars enabling the observer to arrive at the maximum effect of the refraction in the minimum of time?—Experimental verification of Verdet's optical law in the directions near those that are normal to the magnetic lines of force, by MM. A. Cornu and A. Potier.—Specific determination of the imprint of fossil plants in the Carboniferous formations of the Gard, with a view to determining the sequence of the vegetable species and of the stratified rocks in this basin, by M. Grand'Eury.—On the equivalent of the terbines, by M. Lecoq de Boisbaudran.—Remarks on M. Jean Luvini's note on the subject of the conflicting theories advanced by M. Faye and his opponents to explain the action of waterspouts, whirlwinds, and analogous atmospheric phenomena, by M. Léon Lalanne. The author mentions two authentic cases which occurred on the west coast of France many years ago, and which seem inexplicable except on the supposition of *a transverse ascending movement*.—Note on the employment of dynamometric machines for the transmission of force at the marine cannon foundry of Ruelle, communicated by M. Jurien de la Gravière.—Observations of Barnard's comet made at the Imperial Observatory of Rio de Janeiro, by M. L. Cruls. These observations, made with the 0·25m. equatorial, extend over the period from July 15 to August 8, after which date the comet became invisible.—Observation of the nebula in Andromeda made at the same Observatory during the period from September 10 to December 18, 1885, by M. L. Cruls. The angle of position between the *nova* and the central nucleus of the nebula, as well as the angular distance, was measured on two separate occasions, with the following results:—

	Angle of position	Estimated distance
September 17	80°·9	15·0
October 28	79·1	12·1

—Observation of the meteoric display of November 27, 1885, made at the same Observatory, by M. Cruls. The total number of meteors observed between November 26-29 was 1792, the maximum being on November 27, when 73 were seen in five minutes and 1145 during the whole night.—Results furnished by the observation of the solar protuberances at the Roman Observatory during the year 1885, by M. P. Tacchini. The great protuberances were never seen in the neighbourhood of the Poles, but nearly always between the equator and ± 40°, corresponding almost invariably with solar regions free from spots and faculæ. As regards the protuberances, solar energy may be considered as having been more active in 1885 than during the previous year.—Phosphorographic studies for the photographic reproduction of the stars, by M. Ch. V. Zenger. The author describes what he hopes may prove to be an improvement even on MM. Henry's process, which has already yielded such surprising results. He uses the phosphorescence of the sulphurets of the alkaline earths instead of the fluorescence in the preparation of his photographic plates, thereby securing greater sensitiveness and power to reproduce the invisible as well as the visible stars.—Determination of the remainder in Gauss's quadrature formula, by M. P. Mansion.—Note on a geometrical interpretation of the differential equation—

$$L\left(x\frac{dy}{dx} - y\right) - M\frac{dy}{dx} + N = 0,$$

in which *L*, *M*, and *N* denote functions of *x* and *y* at once homogeneous, algebraic, entire, and of the same degree, by M. G. Fouret.—On the coefficient of contraction of elastic solid bodies, by M. Gros.—Analysis of some specimens of the air taken at Cape Horn by the Mission sent to observe the transit of Venus, by MM. A. Muntz and E. Aubin. The mean result of the analysis gave 20·864 as compared with 20·960, Regnault's mean for the atmosphere of Paris. The proportion of oxygen appears to be also very nearly equal to that of the air in various other parts of the globe, so that the variations in the quantities of nitrogen and oxygen in the whole terrestrial atmosphere seem to oscillate within very narrow limits, as was already shown by Regnault in the course of his memorable researches.—Action of gaseous hydrochloric acid on iron, by M. F. Isambert.—Fresh researches on the earthy alkaline manganites, by M. G. Rousseau.—On the reduction of compounds optically inactive by the process of compensation, by M. E. Bichat.—Observation in reference to M. Joly's note on the titration of the phosphoric acids by means of various indicators, by M. R. Engel.—Note on the formation of monatomic alcohols derived from the essence of turpentine, by MM. G. Bouchardat and J. Lafont.—On the action of the alcoholic chlorides on ammonia at a low temperature, and on the methylic amines, by MM. Camille Vincent and Chappuis.—Note on lesions of the alcoholic nevrite, by M. Gombault.—On the *Balanoglossus sarniensis*, by M. R. Kœhler.—On the morphology of the ovary in insects, by M. Ad. Sabatier.—Note on the nervous system of *Echinus acutus*, by M. Henri Prouho.—Note on *Diplosoma Kœhleri*, a new species of Diplosomian recently found in Guernsey, by M. F. Lahille.—On the quantities of heat liberated and absorbed by plants, by M. Gaston Bonnier.—Note on a nephelinic tephrite from the valley of the Jamma, kingdom of Shoa, by M. A. Michel Lévy.—Note on the basaltic rocks of the county of Antrim, Ireland, by M. A. Lacroix.—On the Egyptian decans, by M. Omont.

BERLIN

Physical Society, December 18, 1885.—Dr. Schulze-Berge spoke on the conduction of electricity in dielectric media, a subject which had hitherto been examined in most cases only from a technical standpoint, in order to determine the insulating power of gutta-percha sheathings for telegraph wires and cables. If it were assumed that the resistance of the dielectrics differed with the thickness of the layer according to the same law as prevailed in metals, then—seeing that the resistance of a cubic centimetre of gutta-percha was, in accordance with Jenkin's determinations, equal to 25×10^{12} ohm—the thickness of a layer, the resistance of which amounted to about 100 ohm, and ought to be measurable, must be so small as to be incapable of being produced. It might possibly be the case, however, that in dielectrics the resistance varied in another relation to the thickness, and in point of fact the speaker had found that a gutta-percha layer of 1/13 mm. thickness, and a superficies of 175 square c.m. inserted between two metal plates into the circuit of a Daniell's element connected to earth, produced a very rapid discharge. Measurements executed by the speaker by means of a quadrant-electrometer on thin layers of gutta-percha, sulphur, paraffin, and sealing-wax between two metal plates, yielded resistances very well capable of being measured, and which in the case of gutta-percha amounted on an average to about 200 ohm. In the case of sulphur the values varied between 20 and 2000 ohm, and just as varied and irregular were the resistances in the case of the two other substances. The layer offering resistance was produced by placing rubber tissue or purest flowers of sulphur on a heated plate of zinc, and thereupon pressing the second heated metal plate, after which the whole was allowed to cool. In the course of time the resistance changed. In the case of sulphur it increased, in the case of paraffin and sealing-wax, however, the resistance abated; in the case of gutta-percha the resistance continued pretty equal. If the cells supplying the current were disconnected, and the dielectric brought into conjunction alone with the electrometer, then the latter showed no deviation, whence it was inferred that the dielectric did not conduct electrolytically, and that it was no electrolytic polarisation which caused the change of resistance. The measurements of resistance were also taken with the aid of the Wheatstone bridge, and, after the former results had been confirmed by this method likewise, the influence of the electromotive force on the resistance of the dielectrics was determined. If the bridge system was in equilibrium, then must it remain unaltered when the intensity of the current was varied by the insertion of a changeable resistance into the circuit of the current. The experiment, however, showed that with the change in the strength of the current the needle of the galvanometer indicated a deflection. This change of resistance with the change in the strength of the current was, as the speaker had become convinced, by means also of the bridge combination, through disconnecting the chain, not caused by an electrolytic polarisation, but probably by a dielectric polarisation, which would have to be further investigated after other dielectrics, besides the four mentioned, had been tested. The most important results of his experiments were formulated by the speaker as follows:—(1) The resistance of the dielectrics varied in relation to the thickness of the layer in a different way from metals. (2) The conduction of the dielectrics was not electrolytical. (3) The resistance depended on the electromotive force.—In the discussion following this address, Dr. Schulze-Berge further stated that the sensitiveness of his electrometer was so great that a Daniell gave a deflection of 120°.—Prof. Schwalbe gave a full report of the two volumes on "Geophysik," by Herr S. Günther, published last and this year.

BOOKS AND PAMPHLETS RECEIVED

"Gurina im Obergailthal (Kärnthen)": A. B. Meyer (Hoffmann, Dresden).—"Das Gräberfeld von Hallstatt": A. B. Meyer (Hoffmann, Dresden).—"The Chemistry of the Coal-Tar Colours": R. Benedikt, translated by E. Knight (Bell and Sons).—"Der Schall": Dr. Elsas (Freytag).—"Photo-Relief Map of Scotland": H. F. Brion and Rev. E. McClure (S.P.C.K.).—"Flowers, Fruits, and Leaves": Sir J. Lubbock (Macmillan and Co.).—"Les Aérostats Dirigeables; leur passé, leur présent, leur avenir": B. de Grilleau (Dentu, Paris).—"Führer f. Forschungsreisende": F. F. von Richthofen (Oppenheim, Berlin).—"Tourist's Guide to the Flora of the Alps": Prof. K. W. v. Dallatorre (Sonnenschein and Co.).—"Hand-book of Mosses": J. E. Bagnall (Sonnenschein and Co.).—"The Laws of Nature": S. Cockburn (Sonnenschein and Co.).—"The Elements of Economics," vol. ii. part 1: H. D. McLeod (Longmans).—"Manual of Music": R. Dunstan (Hughes).—"Meteorologische Beobachtungen in Deutschland, 1883," Jahrgang vi. (Hamburg).—"Bulletin of the U.S. Geological Survey," Nos. 7 to 14 (Washington).—"Annual Report of the Comptroller of the Currency U.S., December 1, 1885" (Washington).—"Report of the International Polar Expedition to Point Barrow, Alaska": Lieut. P. H. Ray (Washington).—"On the Structure of the Brain of Sessile-Eyed Crustacea": A. L. Packard (Washington).

CONTENTS

THURSDAY, MARCH 11, 1886

THE SCIENTIFIC RELIEF FUND

A TIME in which so many heartrending calls are being made upon the benevolent seems but ill-adapted for pressing any schemes not immediately connected with any specially urgent distress. There is, however, at present an appeal being made by the Royal Society to all who are in any way interested in science, which, though on behalf of a permanent fund, and not connected with any ephemeral distress, has long been felt to be necessary, and which peculiar circumstances render it imperative now to press forward without delay.

For some years past the Scientific Relief Fund administered by the Royal Society has been found insufficient properly to meet the numerous claims made upon it, and the Committee in charge of the Fund has been frequently hampered in its action in consequence. Of course the demands upon it are variable in their character and extent, being chiefly dependent on what may be called the chapter of accidents; but there are few years that pass without some one of greater or less scientific repute being carried off by an untimely death without having made due provision for those whom he leaves behind him; and perhaps fewer years still in which some earnest worker is not laid low by sickness, and finds himself reduced by an unforeseen chain of circumstances to a condition in which a grant from a fund administered by his scientific brethren is of inestimable value both materially and morally.

The income of the Scientific Relief Fund has not hitherto exceeded some 250*l.* per annum, its capital at the close of last year being about 7500*l.* With the view of increasing this capital sum to at least 20,000*l.* a most munificent offer has been made by Sir William Armstrong, who was among the original founders of the Fund. It is that he will present 6500*l.* to the Fund provided certain conditions are fulfilled, the principal of which is that an equal amount be raised from other sources within the current year. We earnestly hope that there may be no difficulty in accomplishing this, and, with the view of making the scope and character of the Fund more fully understood, we annex a few explanatory particulars.

It was in the year 1859 that the idea of creating a Scientific Relief Fund occurred to the minds of the late Mr. Gassiot and some other Fellows of the Royal Society, and the regulations under which it was to be administered were carefully considered, and, having been adopted by the Royal Society, have remained practically unchanged until the present day. The object of the Fund is defined to be for the aid of such scientific men or their families as may from time to time require and deserve assistance. Cases, however, can only be entertained on the recommendation of a President of one of the chartered Societies, it being understood that he consults the Councils over which he presides as to the person whom he intends to recommend for relief. The Committee administering the Fund, though Fellows of the Royal Society, are not members of its Council, and the senior member of its body retires annually, another Fellow being appointed in his place. It will thus be seen that every reasonable precaution has been taken for the impartial and judicious administration of the Fund; and since its foundation nearly a hundred recipients of well-timed grants have had reason to bless its existence.

It may perhaps be said that men of science ought to be able to foresee what is coming, and be prepared to meet all the changes and chances of this mortal life, and possibly as a class they are more than usually exempt from those reverses of fortune to which all are liable. It is, however, the unforeseen that constantly occurs, and the temporary aid which, by means of such a Fund, a man can receive from a committee of his fellow-workers may be accepted with all gratitude, and without that humiliation which would be felt did the relief proceed from any more ordinary source of charity.

But although men of science may as a rule be prudent, it can hardly be said that they are as a class rich. Their researches may aid others in the acquisition of material wealth, but the cases are exceptional where the pursuit of science has brought large pecuniary gains to the student. Where it has, we are confident that others besides Sir William Armstrong will aid those less fortunate in this particular than themselves by contributing liberally to this Fund.

There is, however, another and important class of persons whose ample fortunes have been the result of the judicious application of science in economic pursuits, and we may be sure that the wants of the Fund have only to be brought under their notice to assure ready and efficient aid in raising the amount necessary to meet Sir William Armstrong's munificent offer. Already we see on the list a noble subscription of five hundred guineas from Mr. Ludwig Mond, and we venture to hope that by thus giving publicity to what is at present being done to enlarge the scope of this most useful Fund, others directly and indirectly interested in science may be led to follow so generous an example.

Looking at the extent to which the material welfare of this country has now for many years been intimately connected with its scientific progress, the debt due from all to the workers in science must at once be appreciated, and a more practical manner of acknowledging this indebtedness can hardly be suggested than that of contributing to the Scientific Relief Fund.

THE BOTANY OF THE ROCKY MOUNTAIN REGION

Manual of the Botany of the Rocky Mountain Region, from New Mexico to the British Boundary. By John M. Coulter, Ph.D., Professor of Botany in the Wabash College. (New York and Chicago: Ivison, Blakeman Taylor, and Co, 1885.)

THE object of this manual, as stated in the preface, is to do for the range of country in which the plants it describes are found, what has for a long time been so admirably done for the North-Eastern States of the Union by Asa Gray's manual. It hence affords a means of comparison between two distant areas, each of such considerable dimensions as to throw much light on the flora of temperate North America. And not only with the flora of the Eastern States does it compare, for, the botany of the great Western area included in California having also been recently worked out, the three floras together enable a fairly accurate estimate to be formed of the nature and extent of the vegetation of the middle regions of temperate North America from ocean to ocean. Thus Gray's manual takes in the States between the Atlantic and Mississippi, which lie north of Tennessee and North Carolina; that is, approximately between lats. 36½° and 46° N., and is essentially the vegetation of a wooded region with high-lands towards the coast. The Rocky Mountain manual occupies a rather smaller area, comprising the States of Colorado, Wyoming, Montana, Western Dakota, Western Nebraska, and Western Kansas. Its southern and northern limits are on the same parallel as those of Gray's "Flora," and its eastern limits (the 100th meridian) is nearly parallel to and as long as Gray's western, and distant from it about 400 miles. Its western frontier is a very irregular one, following the north-western and south-eastern direction of the great mountain plateau; and borders the Pacific States of Washington and Oregon, and the interior ones of Nevada and Utah. It is essentially an Alpine and prairie vegetation; probably most or all of it is above 4000 feet of elevation, with mountains attaining a maximum of over 14,000 feet (Mount Gray). The Californian flora, again, does not occupy half the area of either of the others. It extends rather further south, to lat. 35°, and only to 45° N. Though only 200 miles in average breadth, it is infinitely richer than both the others combined, having a mountain flora—the Sierra Nevada—throughout the length of its eastern boundary, a coast flora along the Pacific, a hill flora along a coast range, and a valley flora between the latter and the Sierra Nevada.

Comparing the areas thus limited with that of the whole breadth of what may be regarded as temperate North America (in contradistinction to the cold British possessions to the north of 48° and the hot ones to the south of 35°), it will be seen that they together cover nearly four-fifths of the breadth of the continent, of which 1200 miles are in the limits of Gray's "Flora," 700 in Coulter's, and (though not in the same parallel) 200 in the Californian. The strips of country not included are, the wooded region west of the Mississippi, and the prairies between the latter and the 100th meridian, and the region of the Great Basin, between the Rocky Mountains and the Sierra Nevada. Neither of them can, however, be expected to add much to the sum of the three floras now under consideration, for on the one hand the western wooded region of the Mississippi cannot add much to Gray's flora or the eastern prairies to Coulter's; and on the other hand, as the Rocky Mountain flora takes in the plants of the western fringe of the Great Basin, and the Californian its eastern fringe, the intermediate region cannot add very much to what these two floras contain.

Dr. Gray[1] has in various essays admirably discussed the characteristics of the three longitudinal zones of North American vegetation, and clearly indicated their composition and relations. In no region of the northern hemisphere, nor perhaps anywhere on the globe, can three parallel meridional floras so different in their aspect and elements be found within such narrow limits, as the middle unforested zone of North America separating two heavily forested ones, the latter differing from one another by hundreds of genera and thousands of species.

The richness of the three floras as expressed by genera and species is, in round numbers—

	Genera	Species	(European)
Rocky Mountain Flora ...	500	1750	(300)
Eastern United States ...	660	2150	(370)
Californian	764	3786	(225)

A striking difference between the Pacific and Atlantic floras is in the relative numbers of the two primary groups of Dicotyledons: the Polypetalæ and Monopetalæ, which in California are as eighteen to ten, but in the Eastern States nearly equal. In both the Incompletæ amount to about one-third of the Monopetalæ, in which respect the Rocky Mountain flora assimilates to the Eastern one. But the most remarkable difference between the three floras is in the relative proportion of Monocotyledons and Dicotyledons, which is about 1 : 2·18 in the Eastern United States; 1 : 3 in the Rocky Mountains; and 1 : 4·9 in California. This is mainly due to the greater number of Junceæ, Cyperaceæ, and Gramineæ in the Rocky Mountains and Eastern States, and the abnormal excess of various Dicotyledonous families in California. So too with the proportion of genera to species: it is nearly the same in the Rocky Mountains and Eastern States (1 : 3·5 and 1 : 3·3), but in California, owing very much to the number of monotypic genera, it is nearly as 1 : 5.

Regarding the composition of the Rocky Mountain flora, the most remarkable facts are the number of Compositæ, amounting to one-fifth of the Phanerogams, thus far exceeding the proportions in the Eastern United States (about one-seventh), and in California (about one-eighth). Of this order nearly forty genera do not occur in the Eastern States. Leguminosæ come next in order of number of species, as they do in California, where, however, they are fewer in proportion to the whole flora. These, with Gramineæ, Cyperaceæ, Scrophularineæ, and Rosaceæ, which follow next in order of numbers (six families in all), embrace half the Rocky Mountain Phanerogamic flora. In the Eastern United States half of the flora consists of seven families, of which the five first are the same as in the Rocky Mountain flora; but Scrophularineæ are replaced by Ericeæ, and Ranunculaceæ are to be added. In California, on the other hand, species of no fewer than thirteen families must be added together to embrace half the flora.

But the most conspicuous difference to the eye between the vegetation of the Rocky Mountains and the Eastern States consists in the absence in the former of almost all the Coniferæ and Cupuliferæ of the latter, together with the whole Orders of Magnoliaceæ, Tiliaceæ, Juglandeæ, Platanaceæ, and Droseraceæ, and the rarity of Hypericineæ, Rubiaceæ, Lobeliaceæ, Ericeæ, Labiatæ, and Orchideæ, and of water-plants generally. On the other hand, there is in the Rocky Mountains a much greater abundance of Cruciferæ, Portulaceæ, Loasaceæ, Cactaceæ, Polemoniaceæ, Borragineæ, Solanaceæ, Chenopodiaceæ, Polygoneæ, and Nyctagineæ,—all show-

[1] "Statistics of the Flora of the Northern United States" (*American Journal of Science and Arts*, vol. xxiii.); "Remarks concerning the Flora of North America" (*American Journal of Science and Arts*, vol. xxiv.); "Vegetation of the Rocky Mountain Region" (*Bulletin* of the United States Geological and Geographical Survey, vol. vi. No. 1, 1881); "Characteristics of the North American Flora" (*British Association Reports*, Montreal, 1882, and *American Journal of Science*, vol. xxviii. 1884).

ing the flora to partake far more of that of the Pacific than of the Atlantic coast. It differs, however, notably from the Californian flora in the paucity of Papaveraceæ, Rhamneæ, Hydrophyllaceæ, Labiatæ, Cupuliferæ, Coniferæ, and Liliaceæ.

The distribution in the United States of America of the 480 indigenous European species,[1] which form an integral part of their flora, offers some very interesting matters for consideration. Of these there are indigenous to the

Rocky Mountain Flora	about 300
Eastern United States	„ 370
Californian	„ 225
Common to all	„ 135

The following list of some of the Rocky Mountain species not found either in the Eastern Alps or Sierra Nevada of California is a very instructive one. No doubt some occur in the northern continuation of the Sierra Nevada, in Oregon, and Washington, &c.; such are therefore plants of the Pacific States, though not Californian:—

Ranunculus hyperboreus, nivalis, pygmæus, and affinis
Thalictrum alpinum
Papaver nudicaule
Draba stellata, incana
Viola biflora
Cerastium alpinum
Sagina nivalis
Elatine triandra
Astragalus hypoglottis
Potentilla nivea
Saxifraga Hirculus, flagellaris, cæspitosa, cernua, adscendens, punctata
Chrysosplenium alternifolium
Epilobium latifolium
Adoxa Moschatellina
Hieracium umbellatum
Campanula uniflora
Androsace Chamæjasme
Gentiana frigida, glacialis, prostrata
Swertia perennis
Lloydia serotina
Juncus triglumis, castaneus
Kobresia caricina
Carex microglochin, rupestris, obtusata, frigida, ampullacea, nardina, gynocrates, incurva, stenophylla, elongata, leporina
Alopecurus alpinus
Deyeuxia lapponica
Catabrosa aquatica

These it will be seen are for the most part Arctic plants, whose presence might be expected on any range of mountains of sufficient elevation in America; but they are absent both in the Sierra Nevada and the White Mountains of the Eastern States. On the other hand, it is not easy to account for the absence in the Rocky Mountains of an even greater number of European species which are found in the Eastern States or in California, or both, and of which some occur in most other meridians of the globe. Such are especially

Caltha palustris
Nuphar lutea
Cardamine bellidifolia and pratensis
Arabis petræa
Drosera (all the 3 European species)
Arenaria peploides
Montia fontana
Oxalis Acetosella
Oxytropis campestris
Rubus Chamæmorus
Circæa lutetiana and alpina
Lythrum Salicaria
Lobelia Dortmanna
Ericeæ (12 species, nearly all Arctic, and both European and Asiatic)
Menyanthes trifoliata
Trientalis europæa
Euphrasia officinalis
Prunella vulgaris
Armeria vulgaris
Myrica Gale
Salix herbacea
Betula alba
Taxus baccata
Rhynchospora alba and fusca
Carex (24 species, chiefly boreal)
Tofieldia palustris
Narthecium ossifragum
Luzula arcuata
Hierochloe alpina
Aira atropurpurea
Glyceria fluitans

[1] In Gray's "Vegetation of the Rocky Mountain Region," cited above, will be found an exhaustive table of comparison of all the Alpine plants of the Atlantic, Pacific, and Rocky Mountain regions as then known. Coulter's "Flora," however, introduces considerable modifications in its details.

Neither the climate of the Rocky Mountain region, its elevation, its geological structure or its physical features, appear to present obstacles to the migration into it of these common plants of the colder north temperate zone from Canada or from the Eastern United States. It is still more difficult to understand how those that occur in all three adjacent American regions should have become excluded from the fourth, which they may be said to bound.

It remains to add that Dr. Coulter's manual is well got up, and though claiming in the preface to be no more than a compilation, it is really a very useful work. The only important omission observed, and it is a very serious one, is that of the elevations at which the plants grow. It is a great advance on the fragmentary "Synopsis of the Colorado Flora" by Porter and Coulter, which was welcome in its day; and though there is no doubt that a good many more species will be found in a future edition, and that some of the data extracted above will be thereby interfered with, there is no reason to suppose that these will clash with the main facts, which so amply confirm all the conclusions that Asa Gray drew years ago from the comparatively imperfect data then at his disposal.

J. D. H.

MORLEY'S "ORGANIC CHEMISTRY"

Outlines of Organic Chemistry. By H. Forster Morley, M.A., D.Sc. (London: J. and A. Churchill, 1886.)

THE faults into which the writer of a text-book of organic chemistry for students is apt to be led are, as Dr. Morley points out in his preface, that of over-elaboration on the one hand, to which the material too readily lends itself, and that of unintelligent abridgment on the other. Dr. Morley adopts a satisfactory compromise by selecting for treatment a relatively small number of typical compounds, giving, however, "as much consideration to each compound as it would receive in a large treatise." Some departures from this rule are, as he candidly confesses, due to the necessity of taking into account "the requirements of students working for examinations."

Dr. Morley's arrangement of his subject is new—so far at least as it has not been anticipated in Prof. Remsen's "Organic Chemistry," which, however, did not appear until after the completion of the present work in manuscript. "I have endeavoured," he says, "to describe compounds in the order in which they may be synthetically produced, so that each compound should be a product of the one before and a producer of the one after." We must confess to having doubts as to how far, save in the interests of very young students, such an entire sacrifice of the symmetry of the ordinary classification as is involved in this arrangement is judicious.

Most text-books of organic chemistry contain, prefixed to each class of compounds, preliminary chapters dealing with the general modes of preparation, the properties and the reactions of the entire class. This arrangement finds no favour in the author's eyes. "Not until he (the student) finds that a series of reactions can be grouped together under some general expression should he be allowed to mention a general law." The principle is doubtless, within its proper limits, sound; but we should be sorry to lay down a hard-and-fast rule. The order of educational exposition is not necessarily identical with that of scientific discovery. Facts are more readily remembered if the principle connecting them is known beforehand. And if a teacher, by offering a few preliminary generalities, can peptonise a rather indigestible mental nutriment, why should he, on purely *doctrinaire* grounds, be forbidden to do so? Did Dr. Morley ever read a novel, and if so, did he never yield to the human temptation of anticipating the course of the narrative by looking at the end?

Dr. Morley has distributed the general reactions throughout the text, calling attention to them, however, by printing them in spaced type. The theoretical sections are as a rule brief, but to the point. An excellent account of the benzene theory is introduced; but we would point out that Hübner has given a simpler proof of the existence of the symmetrical *meta* pair of hydrogen atoms than that of Wroblewsky quoted by Dr. Morley: this proof is based upon reactions of the two nitro-salicylic acids.

The selection of facts is judicious, and, inasmuch as Dr. Morley's plan demanded that each compound should be treated of with considerable fulness, the student can hardly turn to any section of the book without learning all that is of real importance under that head.

Several inaccuracies have crept into the book, although they are not sufficiently numerous to interfere seriously with its usefulness. In his preface Dr. Morley acknowledges his indebtedness to Beilstein's treatise in his search for facts, and we fear that he has not always been sufficiently careful to ascertain how far Beilstein's statements are traversed by more recent experimental results.

Thus on p. 136 the author introduces glycerin ether—formerly dear to classification as the only example of the ether of a trihydric alcohol. But Tollens and Loë have shown that, whatever this compound may be, it is certainly not an ether of glycerin.

On p. 389 it is stated as a universal rule, that, in the conversion of diazo-compounds into substituted azo-compounds, "where nitrogen becomes attached to an atom of carbon in a benzene nucleus, the nitrogen takes up a para-position with regard to one of the groups already present." Mazzara, Witt, Liebermann, and Griess have shown that the nitrogen may also take up the ortho-position.

Following Beilstein the author has altered Wertheim's formula for conhydrine, $C_8H_{17}NO$, into $C_8H_{19}NO$. This has of course been done in order to bring Wertheim's statement, which Dr. Morley gives, that conhydrine may be broken up into water and coniine, into harmony with Hofmann's formula for coniine. But Hofmann has shown that Wertheim's conhydrine formula is correct, and that it is his experimental fact which is wrong: conhydrine does not yield coniine. In this connection it is strange that Dr. Morley makes no mention of Ladenburg's synthetic optically-inactive coniine (a-isopropylpiperidine).

Under piperidine (p. 434) Königs's assertion that pyridine can be reduced to this compound by treatment with tin and hydrochloric acid is given. Dr. Morley must have overlooked Ladenburg's criticism of this work.

In the indigo group we find isatin (p. 386) represented as a lactam instead of as a lactim, and the so-called nitroso-oxindol (in reality isotoxim) formulated as a true nitroso-compound, instead of as an isonitroso-compound. It is of course conceivable that in these two cases Dr. Morley does not share the views put forward in Baeyer's later work on the indigo-compounds.

In the foregoing instances the information is, as already stated, merely not up to date. But there are one or two statements in the book, the source of which we are quite unable to trace. Thus we are told (p. 339) that "anthraquinone forms a compound with bisulphite of soda." If there is one thing that distinguishes anthraquinone from the quinones of the other hydrocarbons with complex nuclei—from phenanthraquinone, chrysoquinone, &c.—it is the fact that it does *not* form a compound with bisulphite of soda.

Again, under the head of ultimate analysis of organic compounds, we read:—

"Many mixtures have been suggested from time to time as substitutes for oxide of copper; the latest is a mixture of potassic chromate and precipitated binoxide of manganese proposed by Dr. Perkin."

Dr. Perkin would indeed have much to answer for if he had proposed such a substitute for oxide of copper. The mixture was proposed as a substitute for *reduced* copper, to absorb the oxides of nitrogen formed during the combustion of nitrogenous organic compounds.

The equation for the action of trichloride of phosphorus on acetic acid (p. 47) is an instance of the strange vitality which symmetrically-constructed and plausible but quite erroneous chemical equations sometimes display. We do not blame Dr. Morley for introducing the equation: it is given in all organic text-books, ancient and modern, from the time of Gerhardt to the present day, and will probably continue to be employed, translated into the notation of the distant future, at a time when our present formulæ have become as unintelligible as cuneiform inscriptions. The correct equation may however be found, by the curious in such matters, in a paper by Dr. Thorpe, (*Chem. Soc. Trans.*, 1880, p. 186), who was at the trouble to work out the reaction quantitatively.

An excellent feature, unusual in an elementary work of this kind, is to be found in the copious references, designed to encourage in students the habit of reading original papers for themselves. F. R. JAPP

THE SPRINGS OF CONDUCT

The Springs of Conduct; an Essay in Evolution. By C. Lloyd Morgan. (London: Kegan Paul, Trench, and Co., 1885.)

THIS is a thoughtful and extremely well-written little book on psychology and ethics, regarded from the standpoint of evolution. There is not much in it that is strikingly original; but the material is so well arranged, and the views so lucidly expressed, that the work constitutes a most interesting epitome of modern thought upon the subjects of which it treats. The author is a man well informed as to his facts, while his ability as an analyst may be remembered by the readers of this journal, in the pages of which it was well displayed a year or two ago in a criticism upon the work of the present writer. On that occasion Mr. Morgan took exception to the study of animal intelligence and mental evolution in animals, on the ground that it is impossible to obtain any verified knowledge of the psychology of brutes, seeing that we cannot directly interrogate them upon the nature of their feelings or mental states. The discussion which followed appears to have had the effect of somewhat modifying his original views; for these, as now stated in his book, are not so severely sceptical as they were when stated in these columns. That is to say, he now appears to recognise the possibility of comparative psychology as a science, although its subject-matter is necessarily restricted by the inadequacy of our "ejective" knowledge of animal intelligence.

We are in such full agreement with the whole essay that our only criticisms upon it refer to matters of comparative detail. These are as follows:—

Mr. Morgan gives it as his opinion that we cannot conceive of matter apart from motion (p. 94), for, in order to do so, we should require to conceive of matter as absolutely cold, "and of such absolutely cold matter we have no knowledge." The fact, however, that we have no knowledge of absolutely cold matter is no proof that we are not able to conceive of matter as absolutely cold. The so-called absolute zero of temperature surely admits of conception as definite as it would were it possible to take an actual reading of its occurrence.

Mr. Morgan's use of the word "instinct" appears to us equivocal. At one time instinctive actions are expressly affirmed to mean adaptive actions of an involuntary and unconscious kind (pp. 226-7); while at another time it is said "Mr. Darwin clearly shows that the satisfaction of any instinctive emotion carries with it a subdued form of pleasure; while, on the other hand, if those instinctive emotions be not satisfied, there results a still more marked feeling of uneasiness, which is a subdued form of pain" (p. 259). Now, clearly, there can be no such thing as an unconscious emotion, an unconscious form of pleasure, or a "still more marked [unconscious] feeling of uneasiness." Mr. Morgan thus appears to have fallen into the inevitable confusion which is the fate of all writers who fail clearly to distinguish between instinct and reflex action, or expressly to include the former term within the territory of consciousness. For these reasons we cannot follow the author's analysis where it leads up to the conclusion that volition is coextensive with consciousness (p. 226 *et seq.*). We may be conscious of the sudden anguish of neuralgia: can it be said that this consciousness is due to, or accompanied by, any act of volition? Mr. Morgan would answer that with the pain there arises a desire that it should cease (p. 229). But, in the first place, a desire is not a volition; and, in the next place, even the desire has here no time to arise before the pain is past.

In one place where Mr. Morgan refers to the views of the present writer, he represents them as differing from those of Dr. Bain, while in reality no difference obtains. First, he quotes the following passage from "Mental Evolution in Animals":—

"What is the difference between the mode of operation of the cerebral hemispheres and that of the lower ganglia which may be taken to correspond with the great subjective distinction between the consciousness which may attend the former, and the no-consciousness which is invariably characteristic of the latter? I think the only difference that can be pointed to is a difference of rate or time, which clearly implies that the nervous mechanism concerned has not been fully habituated to the performance of the response required. . . . Reflex action may be regarded as the rapid movement of a well-oiled machine, consciousness as the heat evolved by the internal friction of some other machine, and psychical processes as the light which is given out when such heat rises to redness. Consciousness is but an adjunct which arises when the physical process, owing to infrequency of repetition, complexity of operation, or other causes, involves what I have before called ganglionic friction."

Now, on this passage Mr. Morgan remarks that he does not consider such ganglionic friction so important a factor in the evolution of consciousness as is "the diffusion of nerve-disturbance" enunciated by Dr. Bain. But surely the former principle includes the latter. For it is only due to this internal friction that the diffusion of nerve-disturbance can be supposed to take place. If all the paths of nervous discharge were freely open, the nervous disturbance would course rapidly and easily along the habitual channels, with comparatively little diffusion as a result. It is only in cases where no one set of paths are more readily open than other sets that alternative directions are offered to the flow of nervous disturbance, with diffusion as a result. The resistances thus encountered—or the ganglionic friction thus created—finds its measurable expression in the delay of eventual response. But although ganglionic friction may arise from such "complexity of operation" (so leading to diffusion), it may also arise from "infrequency of repetition or other causes." Therefore the term ganglionic friction includes all that is expressed by the term diffusion, and differs from it only in being more comprehensive, or in recognising other conditions of cerebral action leading to consciousness, the occurrence of which is always expressed by delay.

George J. Romanes

OUR BOOK SHELF

Spectrum Analysis. Six Lectures delivered in 1868 *before the Society of Apothecaries in London.* By Sir Henry E. Roscoe, F.R.S. Fourth Edition, Revised and Considerably Enlarged by the Author and by Arthur Schuster, Ph.D., F.R.S. (London: Macmillan and Co., 1886.)

This is a fourth edition of a well-known book, and the joint authors have evidently taken some trouble to bring the present edition up to date. To this end, the arrangement of the book, which is rather peculiar, lends itself very well. The peculiarity of the arrangement to which we refer is this. At the time that the lectures were first delivered, now nearly twenty years ago, the literature of the subject was so restricted that Prof. Roscoe found it easy and convenient to reinforce the subject-matter of each lecture by reprinting, immediately after it, the particular memoirs on which it had been based. Hence the first edition was a very precious boon to two classes of people: there was an excellent popular account of the new science, and there were the complete memoirs conveniently brought together for those who wished to go more deeply into the subject.

In the present edition an attempt has been made, as we have said, to bring the lectures more or less up to date, and considering the volume of the work which has been done since 1868, one can understand that this has been no easy task. When we pass, however, from the lectures to the appended memoirs so much cannot be said; indeed the interest of this part of the book is now chiefly antiquarian, if we except reprints of Dr. Schuster's own papers, which are given, we believe, *in extenso*, while Prof. Young's observations on the sun, now fifteen years old, is the latest information we get in the appendixes on any solar matter, English and foreign work being ignored with a magnificent impartiality. In the same manner Vogel's work on the spectra of stars, the most extensive which has been accomplished by any one single individual up to this time, is also passed over, as is also Birmingham's work on the red stars.

We give these as instances of the treatment adopted. No doubt, had the initial idea of the book been carried out in its entirety by the insertion of the most important parts of these memoirs, the size of the volume would have been greatly increased, and this perhaps may be one reason for the violently selective treatment adopted; but it may be urged on the other hand that the value of the book would have been increased much more than its size, and further, that space might easily have been gained for some of the best modern work by the omission of those papers which, as we have said before, are now purely of antiquarian interest.

There was one feature in the third edition which we also regret very much to see dropped in the present one. This was a bibliography running over twenty pages, in perhaps its most convenient form, namely, a list of authors and a complete reference to their memoirs, arranged under the larger groupings of the subject-matter.

Trigonometry for Beginners, as far as the Solution of Triangles. By the Rev. J. B. Lock, M.A., Senior Fellow of Gonville and Caius College. (London: Macmillan and Co., 1886.)

THIS book covers exactly the same ground as Pinkerton's, which we noticed in NATURE, vol. xxxi. p. 148. The two have many good points in common, and we should be well satisfied to use either of them as a text-book. Mr. Lock's great advantage is preceptorial skill in arrangement and exposition. On this score he deserves much credit indeed. There are very few points on which it is possible to suggest improvement. The retention of the expression "circular measure" in all its former importance, notwithstanding the introduction and constant use of the term "radian," is regrettable but not of much consequence: the mode, however, which he employs for indicating the word "radian," *e.g.* writing π^c for π radians, is most unfortunate, and we should hope altogether unacceptable. It is surprising too to find so skilled a teacher following the multitude in condescending to recognise those unnecessary nuisances, "tabular logarithmic sines," &c. Their existence, Mr. Lock says, is due to a typographic difficulty—a statement we hesitate to give assent to; but, be their history what it may, they serve no purpose nowadays whatever, except to roughen the learner's path. Writers require to give them a foolish name and a special symbol, to alter the formulæ for solution, and to burden the learner with additional cautions,—and all for less than nothing. It seems almost malicious indeed to force on a "beginner" such gratuitous absurdities as "natural sines," "logarithmic sines," and "tabular logarithmic sines," when the entities to be dealt with are simply *sines* and *logarithms of sines.* If Mr. Lock in a succeeding edition could see his way to inaugurate the necessary reform here, many teachers would be grateful to him.

The Apparent Movements of the Planets and the Principal Astronomical Phenomena for the Year 1886. Illustrated with Charts showing the Paths of the Eleven Principal Planets among the Stars. By William Peck, F.R.A.S. (Edinburgh: Archibald and Peck, 1886)

BEGINNERS in astronomy will find this little compilation useful. Just the kind of information is brought together in it which persons interested, though not learned, in celestial phenomena want to be supplied with. Technical language, too, is as much as possible avoided, while sufficient exactness for the purpose in view is usually preserved. Not, however, invariably; the statements regarding the two solar eclipses visible in 1886 are so loose as to be misleading. Eleven miniature maps, showing the paths through the constellations during the present year of seven primary and four minor planets, are neatly executed, and ought to prove acceptable to casual observers. Exception must be taken to the introductory assertion that Copernicus swept away all the "complicated machinery of the heavens." His reform of the Ptolemaic system was by no means so complete as Mr. Peck's expression implies. The retention by the Frauenburg astronomer of the old hypothesis of equable circular motion necessitated, in fact, the employment still of no less than thirty-four circles, by which to make plain, as he said, "the entire structure of the heavens"—that is, the revolutions of the moon and of the six known planets.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

An Earthquake Invention

IN NATURE of July 2 last, p. 213, I was accused by Prof. Piazzi-Smyth and Mr. D. A. Stevenson of having attempted to appropriate an invention of Mr. David Stevenson. The invention referred to was the joint introduced by Mr. Stevenson beneath the lamp-tables in certain lighthouses in this country.

In my reply (NATURE, vol. xxxii. p. 573) I pointed out the fact that the aseismatic joint had been independently invented by several investigators of earthquake phenomena, and so far as I was aware Mr. Mallet had appeared to have the prior claim to this invention. My reason for attributing the invention to Mr. Mallet is that when speaking of Japanese lighthouses he says: "I was consulted by Mr. Stevenson as to the general principles to be observed, and these edifices have been constructed so that they are presumedly proof against the most violent shocks likely to visit Japan; not perhaps upon the best possible plan, but upon such as is truly based upon the principles I have developed" (Palmieri's "Vesuvius," p. 43). As the aseismatic joints were portions of the lighthouses especially designed to render them proof against earthquakes, I naturally assumed that Mr. Mallet might be the first inventor of the ball-and-plate joint.

The only occasion on which I have posed as *the* author of the aseismatic joint in question, was when Messrs. Stevenson and Smyth promoted me to that *quasi*-enviable position.

Had these gentlemen recognised the fact that they were only reading a *brief note* about ball-and-plate joints, intercalated in a collection of notes on other subjects, and had they been well acquainted with the recent literature relating to aseismatic tables, they would certainly have refrained from the objectionable accusations made on July 2.

On *more than one* occasion I have referred to Mr. Stevenson's work in Japan. As an example of such a reference, Messrs. Stevenson and Smyth may turn to the *Times* of May 26—*a date which it will be observed is prior to the date of their unwarrantable attack.* In that paper there is a long letter on "Buildings and Earthquakes" signed with my name. When speaking of my house on shot, I there say, "*This experiment was very similar to one carried out by Mr. David Stevenson with regard to the lamp-tables in several of the lighthouses on the coast of Japan.* For several reasons, among which were the movements produced by wind, I abandoned the balls, and now have my house resting at each of its piers upon a handful of cast-iron shot. These shot, which are about the size of buckshot, have so increased the frictional resistance to rolling, that the house is practically astatic, and the motion in the house is in most earthquakes only about one-tenth of what it is outside."

I make especial reference to the *Times*, first because it is a paper which many Englishmen have often the opportunity of seeing; and second, because the article in question occasioned considerable discussion.

With this reference to the relationship of my experiments to those of Mr. David Stevenson, and I will furnish others if required, I think it would only be just for Prof. Piazzi-Smyth and Mr. D. A. Stevenson to withdraw their accusation of July 2.

I must now refer to a second point which Mr. Stevenson has raised. In your issue of August 6 Mr. Stevenson appeals to the results of my experiments as showing the value of his aseismatic tables. All my experiments with aseismatic tables, whether used for seismographs or buildings, when approximating in form to Mr. Stevenson's joint were, for a variety of reasons, unsatisfactory. Under compulsion I have stated that Mr. Stevenson's joint itself, as applied to the lighthouses of Japan, has been unsatisfactory. I did so for the following reasons:—

(1) Shortly after erection the free motion of the tables occasioned so much inconvenience, that the European engineers then on the Japanese service had them clamped. For this reason Mr. Stevenson's arrangement was not adopted in lighthouses which were subsequently erected (see Brunton on "The Japan Lights," Institute of Civil Engineers, No. 1451, p. 9).

(2) I learn from the Lighthouse Department that in 1882, wishing to give Mr. Stevenson's tables another trial, several of them were put in working order. The result has been that on March 11, 1882, at Tsurgisaki, a number of lamp-glasses on the burners on the aseismatic tables were overthrown.

Some time afterwards a second shock produced a similar effect. At neighbouring lighthouses, of which there are several (two being within 8 miles), not provided with aseismatic tables, no damage was sustained.

The shock of March 11, 1882, which was felt for at least 300 miles along the coast, was severe, and its effects at Yokohama and Tokio, which are no great distance from Tsurgisaki, were carefully recorded. I am not aware that any small articles like lamp-glasses, bottles, vases, &c., were overthrown inside ordinary houses (see *Trans. Seis. Soc.*, vol. vii. part ii. pp. 41–44). The fact that no ill effects occurred at other lighthouses provided with Mr. Stevenson's tables, like those on the Inland Sea and near Kiushiu, must not be regarded as an argument in favour of the tables, inasmuch as the earthquake referred to was not felt in those districts.

I may here remark that several of the aseismatic tables are at places where earthquakes are almost as rare as they are in Britain. Mr. Stevenson tells the readers of NATURE (June 26) that his lighthouses suffered when the aseismatic tables were *not* in working order. I have shown that they suffered when they were in good working order.

Speaking generally about Mr. Stevenson's descriptions of his aseismatic arrangement, he invariably refers to it as a great success. Where it was applied, earthquakes have produced no effect, but where it was suppressed, evil effects have resulted. After inquiries at the Lighthouse Department, which is a branch of my own department, I find that the facts adduced by Mr. Stevenson are exactly the reverse of the facts which have been placed at my disposal; and from what I learn, and from my own experiments, I conclude that thus far Mr. Stevenson's tables have been a failure.

As a further support to my conclusions I will quote the following translation of a report from the chief lightkeeper at the Tsurgisaki Lighthouse:—

"Sir,—On October 15, 1884, at 4.16 a.m., very severe shocks of earthquake were felt. The aseismatic table was in working order, but the shocks were so violent that fifteen lamp-glasses out of twenty-one in use were upset and broken. The lamps thus stripped of glasses began to smoke. The milled heads of the wick-holders being shaken off, and besides the revolving machine being in motion, we had some difficulty in replacing the glasses promptly; however, we managed to put them all in proper order again by 4.21 a.m.—I am, Sir, your obedient servant, &c., &c."

The only form of aseismatic joint that I have found at all practical is one where something more like a layer of cast-iron sand rather than a bed of cannon-balls is used to break the continuity between a structure and its foundations. I arrived at this after spending much time and, I may add, a considerable sum of money, and although the method involves the same *principle* as Mr. Stevenson's tables, I hardly think he is justified in claiming my successes to back up what I cannot but feel have been his failures.

If the ways and means permit, I hope to make experiments upon a small building resting on a bed of sand or fine gravel. Should results of any value be obtained, surely Mr. Stevenson will not expect me to do more than I have done already—namely, to state the relationship which may exist between these experiments and those which he carried out at the expense of the Japanese Government.

If everything connected with earthquake investigation which involves the same *principles* as are involved in Mr. Stevenson's lighthouse tables are to be regarded as his creations, he cannot avoid claiming the rolling sphere seismograph, the rolling cylinder seismograph, the horizontal pendulum seismograph, the conical pendulum seismograph, and in short, a very large proportion of the work accomplished by the Seismological Society of Japan. To this I cannot assent. All that Mr. Stevenson can be accredited with is a particular *method* of applying a principle, and this method has to my mind been a failure.

The question of the *principle* involved in Mr. Stevenson's device is one that has been *repeatedly* discussed in Japan. As an example of these discussions I will refer to the *Transactions* of the Seismological Society of Japan, vol. iii. p. 9, where Prof. J. A. Ewing is speaking, amongst other things, about a rolling sphere seismograph, the invention of Mr. Thomas Gray. Prof. Ewing says that Mr. Gray's contrivance was an application of "the method of supporting a mass by a movable piece in such a manner that the connection with the earth was at the centre of percussion of the movable piece, the mass being at the corresponding centre of instantaneous rotation, while at the same time the supporting piece was arranged so that its movements did not introduce any disturbing force due to the action of gravity upon the mass. This kinetic property, common to all these instruments, he believed he might fairly claim to have introduced into seismometry."

If Messrs. Stevenson and Smyth see fit to comment upon these notes, I trust that they will distinctly state whether they yet consider that I have attempted "to get round the letter" of Mr. David Stevenson's invention, and whether they were justified in publishing the objectionable personalities about "a B.A. man" on July 2.

This is the main point at issue, and if they choose to neglect it, the discussion may be considered as ended.

In conclusion I may remark that it was not I who commenced this controversy. JOHN MILNE

Tokio, January 6

On the Velocity of Light as Determined by Foucault's Revolving Mirror

A FEW years ago Lord Rayleigh raised an interesting question as to the quantity actually determined by our experiments and observations on the velocity of light. There can be no difficulty as long as the medium transmits different wave-lengths with the same velocity, but whenever the medium possesses the property of dispersion the velocity with which any one crest of a wave travels (V) is different from the velocity with which a group of waves is propagated (U); hence the question arises in each particular case, whether it is V or U or something depending on both quantities that we measure.

In his first article on the subject (NATURE, vol. xxiv. p. 382) Lord Rayleigh states that, in experiments with Foucault's revolving mirror, the group-velocity, U, is determined; but subsequently (vol. xxv. p. 52) he corrected this statement and gave V^2/U as the quantity measured. A paragraph was added, however, in which the remark is made that, if a convex lens is interposed so that an image of the slit is formed on the fixed mirror, the rotation of wave-front, caused by the different velocities of different wave-lengths, and acquired on the outward journey, is neutralised during the return, so that in this case we should measure V.

Gouy (*Comptes rendus*, ci. p. 502, 1885) dissents from Lord Rayleigh's second view, and gives U as the quantity determined; without, however, giving sufficient reason in support of his opinion.

Finally, Michelson has performed the experiment with bisulphide of carbon, and obtained a result in close agreement with U. In a discussion of Michelson's measurements in the *American Journal of Science*, by J. W. G., his result is said to give "no countenance" to the theory which would make the velocity observed V^2/U.

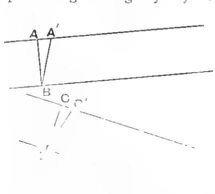
It is the object of this communication to support Lord Rayleigh's value V^2/U for the arrangement considered by him, but to point out that, if only one revolving mirror is used, the experiment cann t be performed in this way. The lens spoken of in Lord Rayleigh's s cond note is, then, a necessary condition of the experiment. When the lens is used it seems to me, however, that the result ought not to be a neutralisation of effects, but rather an equal rotation in the opposite direction. I have Lord Rayleigh's authority for stating that he agrees with this conclusion.

The method of Foucault's revolving mirror thus measures neither V nor U, nor V^2/U, but $V^2/(2V - U)$. As V and U differ by a small amount only, the last expression becomes nearly equal to U, so that Michelson's experiment is in complete agreement with theory.

In Foucault's experiment, it is well known, the displacement of an image is measured which is due to the rotation of a reflecting mirror in the time of passage of the light from the mirror to a fixed mirror and back again. But in order that this quantity should be capable of measurement, it is necessary that a displace nent of the mirror should not by itself alone cause a displacement of the image.

The following consideration will show what conditions this imposes on the arrangement of the experiment.

In the accompanying figure let A B be the position of a wave-front as it leaves the mirror (supposed fixed). Let C D be the position as it returns to the mirror. I have drawn the wave-surfaces plane, for the sake of simplicity, but the argument remains the same if they are curved. The point A may correspond to the point C on the returning front or to the point D. If now the mirror is displaced through a small angle, the wave-front takes a different position, A′ B. If this displacement shall not change the position of the image after reflection from the mirror, the returning wave must turn through the same angle and take up the position C′ D. But it is easily seen that, in order that this may be possible, the point A must correspond to D and B to C, for the optical length along any ray between two wave-



fronts remains the same; also, owing to the maximum-minimum property, we can still measure optical lengths in the displaced position along the original paths; and the length of the ray leaving A having been shortened by a distance A A′, the ray leaving B must be shortened by an equal amount, C C′—that is to say, the ray arriving at C must be the one leaving B, and the ray arriving at D must be the one which left A. We may then express the condition of a stationary image thus: The wave-surface must be inverted by the optical arrangement interposed, and the magnifying power of this optical arrangement must be equal to one. The last part of the condition is rendered necessary by the fact that the width of beam must remain the same; otherwise A A′ could not be equal to C C′. If both conditions are fulfilled, the image will remain distinct in the rotating mirror, otherwise it would be drawn out into a band.

But an arrangement is possible, at any rate theoretically, in which the wave-surface is not inverted. We might have a second mirror rotating in such a way as to neutralise the effect of displacement. For this purpose the second mirror ought to rotate twice as fast as the first, the light being sent on to this second mirror on its way back only, after reflection from the first revolving mirror. As the angular velocity of the two mirrors must have their velocity accurately adjusted, the experiment would be difficult to perform, but it is important to point out that it is theoretically possible.

Returning now to Foucault's arrangement, consider two successive wave-fronts as they leave the revolving mirror. The distances between them will be larger on the receding than on the preceding side of the mirror. That part of the wave-front which is on the receding side will thus be propagated more quickly in a medium having dispersion, and whatever happens to the wave-front on its journey, whether it is refracted, reflected, or inverted, that side of it which left the receding part of the rotating mirror will always gain on the other. When the wave-front returns to the revolving mirror, it will have rotated through the angle given in Lord Rayleigh's second note; but we have to consider the direction of rotation.

If that part of the wave-front which left the receding half of the mirror will return again to the receding half, the final rotation of wave-front will be in the same direction as the rotation of the mirror; and the displacement of the image which depends on the relative rotation of mirror and wave-front will be diminished. In this case, however, as I have shown, we want a second revolving mirror, otherwise the image of the slit will be drawn out into a band.

In the experiments hitherto performed, the wave-front is inverted an odd number of times between the two mirrors, and hence that part which left the receding side of the revolving mirror will now be on the preceding side. The relative rotation being increased, the observed displac ment of the image will be increased.

The total observed rotation will thus, with Lord Rayleigh's notation, be

$$\frac{4Dw}{V}\left(1 + \frac{d \log V}{d \log \lambda}\right),$$

or the velocity of light calculated will be $V/\left(1 + \frac{d \log V}{d \cos\lambda}\right)$. As $U = V\left(1 - \frac{d \log V}{d \log\lambda}\right)$, the apparent velocity becomes equal to $V^2/(2V - U)$. If $\frac{d \log V}{d \log\lambda}$ is small compared to unity, we may write the expression for the apparent velocity approximately

$$V\left(1 - \frac{d \log V}{d \cos\lambda}\right) = U.$$

In the case of bisulphide of carbon, J. W. G., in the passage quoted above, gives for the green rays $K/V = 1·637$, $K/U = 1·767$, K being the velocity *in vacuo*. From this we get for the theoretical value of the quantity observed in Michelson's experiment 1·758, being identical with the value 1·76 actually observed.

If a second rotating mirror is used, as described, Lord Rayleigh's value V^2/U remains true.

We have then as a final result, that, while the aberration of light measures V, and the eclipses of Jupiter's satellites and Fizeau's experiments measure U: Foucault's revolving mirror measures either $V^2/(2V - U)$, or V^2/U.

ARTHUR SCHUSTER

Variable Stars

IN the last number of NATURE (p. 397) Prof. Seeliger, of Munich, is represented as thinking "it not improbable that the blazing forth of the *Nova* may have been due to a collision which caused an enormous development of heat and light." It appears to me that the collision hypothesis is not necessary, and that the variability of a star is a physico-chemical consequence of mere cooling. This conclusion is based on considerations relating to the formation of the chemical elements.

If we suppose a mass of primitive matter, say gaseous, to be cooling down, it will from a chemical point of view undergo a series of changes such as are indicated in the known transformations I to I_2, NO_2 to N_2O_4, &c.; in short, it will produce a succession of polymers. When, however, each stage of polymerisation is exactly reached, the formation of each new polymer being attended with an increase of density, will, from a physical point of view, lead to an evolution of heat. This evolution of heat will occur periodically as polymerisation goes on; and if the heat be sufficiently intense, there will be a corresponding periodic development of light. The number of such periods will doubtless depend on the nature of the primitive matter, and the difference between its temperature and that of its environment. I cannot recall an instance where, in the laboratory, more than three polymeric periods have been attained; but celestial events have a wider range and greater possibilities.

The evolution of heat which necessarily occurs at the point of polymerisation involves of course a partial reversal of the polymerisation. Elements therefore will be formed which may be regarded as derived from successive polymers by virtue of such reversal.

In the *Philosophical Magazine* for November 1884, and for February 1886, I have shown that the numerical value y of the symbol of an element within the common system is given with great accuracy by the equation

$$y = 15p - 15(\cdot9375)^t,$$

where p is the number of the period, and t is a whole number, easily approximated to, on the scale of celestial temperature. Our ordinary elements—that is to say, all that are known to us with the exception of hydrogen—are thus seen to correspond to what might be expected from a law of polymerisation affected by the inverse of Dulong and Petit's law of cooling. They appear to be comprised within sixteen periods only.

These considerations lead to the inference that a variable-star is one that is engaged in making "elements." All stars, therefore, either are, or must at one time have been, variable-stars.

Glasgow, March 1 EDMUND J. MILLS

Do Young Snakes take Refuge in the Stomach of the Mother?

THE letters of Messrs. Middleton and Creole (NATURE, vol. xxxiii. pp. 176 and 269) in relation to the above-indicated reputed habit of serpents, directed my attention to some considerations and facts bearing upon the question at issue.

It has long been a popular belief—in relation to the European viper, as well as the American rattlesnake—that when the female is suddenly surprised she opens her mouth and permits her young to *run down her throat*. Some of the English viper-catchers deny that any such thing ever happens; and for a long time I was disposed to ascribe the origin of the popular opinion to the fact that, these serpents being *ovo-viviparous*, they are sometimes found with the young in the *oviduct*; which might lead persons to suppose that they were in the *stomach*. But the following account, given by the well-known French naturalist and traveller, M. Palisot de Beauvois, is so *direct* and *positive*, that my faith in the above explanation has been seriously shaken.

He asserts "that he saw a large rattlesnake, which he happened to disturb in his walks, coil itself up, open its jaws, and instantly receive five small ones which were lying by it and instinctively rushed into its mouth. M. de Beauvois retired and watched the snake, and, about a quarter of an hour after, he saw her discharge them. He approached a second time, when the young retired into its mouth with greater celerity than before, and the snake immediately moved off among the grass and escaped" (*vide* Rees' "Cyclopædia," vol. x., Article "Crotalus," cited from the *Transactions* of the American Philosophical Society). Testimony so clear and distinct from a scientific man is hardly to be gainsaid. JOHN LE CONTE

Berkeley, California, February 17

The Coal-Dust Question

SIR FREDERICK ABEL has not fortified his statement by even one quotation from the writings of one of those workers "antecedent to and contemporaneous with" myself, who, according to his letter in the last number of NATURE (p. 417), have taken the variable specific heat of air into account in drawing comparisons between experimental effects obtained in practically open apparatuses and the corresponding effects to be expected in a great explosion taking place in the practically closed space represented by the workings of a mine.

Secondly, I am entirely at a loss to know what are the "very obvious facts" which forbid the conclusion at which I have arrived, namely, that coal-dust plays the principal part in most great explosions in mines. They have not yet been pointed out by any author so far as I have been able to learn.

Lastly, Sir Frederick's statements, to which I called attention in my letter in NATURE of December 31 (p. 197), were made for the most part before popular audiences, very few of whom will probably take the trouble to wade through the Report of the Royal Commission on Accidents in Mines in order to verify his concluding remarks for themselves. W. GALLOWAY

Permanent Magnetic Polarity of Quartz

To my letter in NATURE for February 25 (p. 391) you have added an editorial note, quoting a passage from Tumlirz's paper which has no bearing on any of the points at issue.

In your original note you stated that Tumlirz has discovered a permanent diamagnetic polarity of quartz. To this I objected, saying that the permanent polarity was paramagnetic, not diamagnetic, and you reply by a quotation stating that quartz is a diamagnetic body showing permanent polarity, a very different statement indeed from your original one.

A permanent diamagnetic polarity could only mean that quartz placed between the poles of a magnet should show permanent north polarity at the end placed opposite the North Pole. Tumlirz is perfectly distinct and explicit that this is not the case, but that the permanent polarity acquired is in the same direction as it is in iron. There is no room for two opinions as to the meaning of Tumlirz's words.

ARTHUR SCHUSTER

[Our correspondent who furnished us with the original note informs us that Prof. Schuster was entirely right in the definition of the term diamagnetic polarity, and that his informant in Vienna had been misled in using the phrase permanent diamagnetic polarity for permanent polarity of a diamagnetic body. The sentence which we quoted from Dr. Tumlirz's now-published paper we quoted because it is the one in which he points out the essential novelty of his discovery, which we and our correspondent regarded, and still regard, as one of very great importance. Our thanks are due to Prof. Schuster for pointing out the ambiguity.—ED.]

The "Muir Glacier" of Alaska

IN Mr. G. W. Lamplugh's interesting article on "The 'Muir Glacier' of Alaska," published in your issue for January 28 (p. 299), appears the erroneous statement that Glacier Bay opens into Chilcoot Inlet. Chilcoot Inlet is at the head of Lynn Canal, the approximate latitude and longitude being 59° 20′ N., and 135° 20′ W. Glacier Bay opens into Cross Sound (or Icy Strait) about latitude 58° 30′ N., and longitude 135° 50′ W. Lynn Canal is an extension of Chatham Straits, both running nearly north and south. Cross Sound connects the latter with the Pacific Ocean, and runs nearly east and west, entering Chatham Straits south of the southern limits of Lynn Canal.

Washington, February 25 CHAUNCEY THOMAS

THE SURVEY OF INDIA [1]

IT has been well said that "l'exacte connaissance topographique qui est un facteur de l'avancement des sciences et de leurs applications pratiques, est aussi un élément constitutif du progrès national."[2] India is a country which, ever since the establishment of British dominion in the east, has been prolific of surveys of very various degrees of exactitude, ascending from the rough and rude reconnaissances which were needed for the speedy acquisition of some knowledge of the general geography, to, first, a fairly close representation of all topographical features, and, finally, to an exact delineation of the boundaries of all properties—of private individuals as well as of the State—in the richer and more densely populated portions of the British districts. Commencing at the coast lines, with the primary object of furnishing charts for the guidance of navigators, with a view to the rapidly-increasing traffic between India and Europe, they were extended inland, here and there, as different parts of the country became subject to British influence. Astronomical determinations of the latitude and longitude were employed in the first instance as a general basis for the geography, but not proving satisfactory, they were abandoned at the commencement of the present century, when the Great Trigonometrical Survey was originated, which has been of such value for geodesy, as well as geography. The survey work may be broadly classified as non-graphical and graphical, the former trigonometrical and geodetic, the latter delineative of the configuration of the ground and of whatever has been raised on its surface.

[1] "General Report on the Operations of the Survey of India Department, administered under the Government of India during 1883-84." Prepared under the direction of Col. G. C. De Pree, S.C., Surveyor-General of India.

[2] "Importance de la Cartographie officielle." C. D. Carusso. Genève, 1886.

For many years survey operations of various kinds were carried on independently by distinct agencies. Of these the most notable were the Revenue and Settlement Departments under the Governments of the Madras and Bombay Presidencies and of the several provinces of the Bengal Presidency, and the Great Trigonometrical, the Topographical, and the Revenue Departments under the Supreme Government. The three last were amalgamated, in 1878, into a single department, styled the Survey of India, the report of which for 1883–84 we are about to review.

The survey year in India is invariably divided into the two periods of the field season and the recess, which are mainly governed by climatic conditions, and vary greatly in different parts of the country according as the monsoons set in or terminate early or late. For the surveys under the Supreme Government it is held to commence on October 1, when most of the survey parties are preparing to leave their recess quarters and return to the field. The annual reports are prepared for the survey year, as distinct from both the calendar and the official year. This one has been issued somewhat tardily, fully a year after the close of the period it embraces.

The operations were mainly geographical, topographical, and cadastral.[1] The principal triangulation having been completed in 1882, it is now only necessary to construct occasional minor triangulations. A chain was carried along the coast of Orissa and Gaujam to establish beacons for the use of the Marine Survey. Another was contemplated in extension of the principal triangulation terminating below Mergui and Tennasserim, at the southernmost point of the British-Indian territories on the Malayan Peninsula, to connect the Straits Settlements and Malacca; but it had to be held in abeyance in view of financial exigencies; thus Singapore still remains unconnected geographically with India, though Bangkok, the capital of Siam, has been well connected by a chain of triangles carried eastwards from Tavoy. And now that Upper Burmah has been annexed to the dominions of the Queen-Empress, the triangulation to Singapore must give way to what is more urgently required for the geography of the newly-acquired provinces.

Some idea of the variety and extent of the topographical operations is afforded by the following statement of the out-turn of area surveyed on different scales during the year:—

4034	square miles on the scale of	¼ inch = 1 mile
3225	,, ,,	½ ,, ,,
7437	,, ,,	1 ,, ,,
12074	,, ,,	2 inches ,,
692	,, ,,	4 ,, ,,
110	,, ,,	6 ,, ,,

in addition to which areas of 875 and 310 square miles were surveyed on the 4-inch scale, the former to supply working plans for the Forest Department, the latter to enable village boundaries to be relaid in riverain tracts, where they had been swept away by floods. The topography was carried on simultaneously in widely distant regions, in Biluchistan and in Burmah, in the Andaman Islands of the Bay of Bengal, and in the Native States of Rajputana and Cutch in Western India; also in the Guzerat and Deccan provinces of the Bombay Presidency. It may excite surprise that these last, which are among the oldest of the British possessions in India, should now be under regular topographical survey, and for the first time; but as a rule more attention has been paid to the topography of our later than our earlier acquisitions of territory. Good maps were prepared for the Punjab and Oudh as soon as possible after their annexation, under instructions from Lord Dalhousie and Lord Canning, at a time when very inferior ones were forthcoming for the North-West Provinces and Bengal: and to this day some of our oldest possessions have no better topography than was acquired by reconnaissance on the ¼-inch scale early in the present century. These tracts are taken in hand as the requisite agency becomes available on the completion of surveys elsewhere.

Indian topography is entirely executed by the method of plane tabling on a trigonometrical basis, which, though well known on the Continent, is but little practised in England, and is not adopted by the Ordnance Survey. When a plane table is employed, all the details of the ground may be "fixed" by direction intersections laid off on the table, and all instruments for direct linear measurements may be dispensed with; this is a great advantage in surveys of tracts of mountains where chains cannot be conveniently employed, and in native States where they are objectionable for political reasons, raising a suspicion that lands are being measured with a view to annexation; and it has the further advantage of enabling the details of the ground to be drawn on the spot, whereby field-books are dispensed with and the rate of progress is much accelerated. In accuracy it cannot compete with the Ordnance Survey system of triangle-chaining; but it is better suited for ordinary topography in India, and best of all for rapid geographical reconnaissance everywhere; and it may be supplemented by chaining to any extent that may be desired for cadastral and other large scale surveys.

The out-turn of the work of the Cadastral Survey parties was as follows:—

	Square miles		Fields
In the North-West Provinces...	1747	comprising	1,863,000
,, Burma	1749	,,	1,608,000
,, Central Provinces ...	31	,,	40,000
,, Assam	228	,,	148,000
Total ...	3755	,,	3,659,000

Of the total area, 11 square miles were surveyed on the 32-inch scale, and the remainder on the 16-inch scale; the average areas of the fields ranged from ·12 to ·98 of an acre in different districts, the general average of all being two-thirds of an acre.

Cadastral Survey operations have hitherto been mainly carried on conjointly by the Survey and by the Settlement Departments, with the double object of furnishing correct maps of all properties, and records of the rights of every individual proprietor and tenant. Such maps and records are obviously of enormous value in the administration of the country; but they are necessarily costly, and therefore it has long been, and is still, a moot point whether they are absolutely necessary. Records of rights and liabilities to taxation were constructed at each of the successive periodic settlements of revenue under the Asiatic Governments anterior to the British, but no maps were made. During our first settlements no attempt was made to obtain accurate maps; some attempt was made to ascertain the areas of the fields with fair approximation by measures of lengths and breadths with poles and ropes of a length regulated by that of the forearm of the measurer, obviously a very variable and indifferent standard unit; and from these measures rude outline sketches were constructed which were serviceable as furnishing a graphical index to the record of rights of each village, but of course were not true maps showing all boundaries of property correctly. In the modern Revenue and Settlement Survey of the Bombay Presidency accurate map construction was deliberately set aside, lest it might interfere with the classifications of soils and the investigations of tenures and rights which were deemed of greater importance. In the Madras Presidency its advantages were recognised, and good maps were made from the first, but the results were costly. In Northern India there has been a continuous endeavour

[1] The term "cadastral" is applied in India to a field-by-field survey which gives an outline-map of all properties and statistical information relating thereto; it is derived from the French word "cadastre" = rental book, which comes from "capitastrum," a register for taxation of individuals.

on the part of the settlement officers to improve the field survey and construct good maps; but it has been attended with varying success, indifferent at best; for though a theoretical knowledge of the first principles of surveying, which are very simple, is readily acquired, a practical knowledge of their application in the combination of a vast number of mutually interdependent measures, with all the desirable accuracy, is not so easy to acquire; it needs much skill and judicious organisation; the ground measurements are necessarily made by the cheapest agency procurable; many measurers have to be employed simultaneously, and they have to be systematically supervised in order to guard against both accidental mistakes and intentional falsifications. Thus in the Bengal Presidency the Survey Department has long been called on to co-operate with the settlement officers to some extent. All village or parish boundaries have been carefully surveyed, and plane-table sketches of the interior have been made, distinguishing the cultivated from the uncultivated lands; and the areas of the entire village, the cultivation, and the waste thus determined have been employed as a check on the gross areas derived from the field measurements of the settlement officers. The results thus obtained were long considered sufficient for practical purposes, though the maps were still far from accurate, for it was merely the areas that were checked, not the mapping of the fields and boundaries of property. But as the country grows in wealth and civilisation, the want of accurate cadastral maps is more and more felt; and the question has arisen, How are they to be obtained in the future? whether wholly by the Professional Survey, or by the Settlement Department, as formerly, but with greater assistance from the surveyors, by getting the latter to subdivide the village area into several accurately-outlined blocks, each no greater than the field-measurers can be expected to fill in with accuracy? The merits of the two rival systems are hotly contested; the Governments of the Punjab and the Central Provinces have declared in favour of the modified settlement system, whole those of the North-West Provinces and Burmah are in favour of the professional survey; and the surveyors and the settlement officers are each declared by their respective backers to be the fittest to survive in what has come to be regarded, in some quarters, as a struggle for existence.

There are three essential requirements for administrative purposes, a correct map, a classification of soils, and a record of individual rights, and at first sight it would seem desirable to have each of these performed by a separate class of experts. Thus, when the professional surveyors were called on to undertake the field measurements, it was intended that they should simply make a survey of the ground, and leave the business of classification and recording rights to others; but, though in most instances this would have sufficed to secure what was wanted, in very many it would have failed to do so, because several boundaries of property are either quite unmarked on the ground, or so faintly marked that they must be specially pointed out to the surveyor; while, on the other hand, many prominently-marked divisions of land are not boundaries of property. If, then, the surveyor simply made a survey of what he saw, assigning a number to each plot of land on his map for ready identification, the settlement officer following him had sometimes to break up, sometimes to combine, his plots, and institute a new series of numbers for the record of rights, all which caused trouble, expense, and delay, and might necessitate the construction of a second map. Thus, it was found that the surveyor had to survey not what he saw, but what was wanted by the settlement officer, and this necessitated his entering into communication with all the landed proprietors and tenants and squatters.

Now in India and Asiatic countries generally there is this standing objection to any invasion of a district by Government officials, more particularly when made with a view to inquiries about rights of proprietorship and occupancy, that the inhabitants invariably consider it a judicious precaution in their own interests to conciliate the officials and win their favour by substantial presents, even when they have no rival claimants to fear, and when they have, the conciliatory gifts are liable to merge into bribes of ruinous magnitude. Thus every district is invariably impoverished more or less by the passage over it, and still more the protracted residence in it, of a body of native officials, and the less it is subjected to such invasions the better for its welfare. In this respect there is a decided advantage in having the survey, the classification, and the record of rights executed simultaneously by the officials of a single department working under a single officer; and there is the further advantage that the presence of the villagers in attendance on the officials is required much less frequently when all three investigations are made simultaneously than when each is conducted separately. Thus in some of the districts in which cadastral operations are now being carried on, the survey officers have been called on to undertake, in addition to their ordinary duties, the classification of soils and the entry of all *undisputed* items in the record of rights, and to furnish a list of all disputed items, with the requisite information to enable the disputes to be settled either by an officer specially appointed to do so, or by one of the higher courts of justice. This new system has not been long on trial, but it is expected to be very satisfactory in being less costly to the Government and less oppressive on the people of the country. The Survey Department has the great advantage of a staff of European subordinates to control the accuracy of the field measurements; its system of operation is cheap native agency closely supervised; its officers can control the classification of soils and the preparation of the record of rights as well as the ground measurements; and close supervision is a *sine quâ non* wherever subordinate native agency is largely employed.

The question of the best system of cadastral survey is one of especial importance at the present time, for the Government of Bengal contemplates carrying out such a survey in the districts which were permanently settled by Lord Cornwallis in 1792. When that settlement was effected the Government ceased to have any direct interest in the land so long as the annual payments of revenue were made with punctuality. The land has greatly increased in value, and the lightly assessed revenue has been paid with ease and without demur; but meanwhile great changes have taken place in proprietary rights, and of these there is little official record; lands have changed hands, and the settlements of zamindars with ryots, or landlords with tenants, have not by any means been of the permanent and easy nature of the one made by the Government with the landlords; on the contrary, rents have been raised to the utmost, and disputes between the zamindars and the ryots are constantly coming before our Law Courts, which have no record of rights and no map to guide them to a correct decision. When the permanent settlement was effected, nearly a century ago, it was provided that a "patwari," or village accountant, should be maintained to keep the record of rights, and correct it up to date on all occasions of subdivision or clubbing of land; but no steps were taken to carry out this provision, and in Bengal the "patwari" has long become extinct, doubtless to the great advantage of the rich and the strong over the poor and the weak. And now the former are crying out that they do not want a survey, while the latter have not as yet commenced to ask for what they have not yet learnt to understand and appreciate. But many of the higher officials of Government think it imperatively necessary for the just administration of the country.

One of these officers maintains that there can hardly be two opinions as to the abstract desirability of a cadastral survey; that it would be difficult to conceive a greater boon to the province than would be the existence at the present moment of a complete series of cadastral maps, with their accompanying detailed records of possession and of title; that to measure the extent to which such a record would facilitate administration and promote economic progress, it is only necessary to realise the vast quantity of interminable litigation, more or less connected with the land, that burdens the civil and criminal courts, and drains the resources of the agricultural population. Out of the many criminal cases, true or false, that are brought to determine questions of title or possession in village fields—out of the concurrent and still more harassing civil litigation on the same subject—a very great proportion would certainly never have arisen at all, but for the lack of survey records, and in the remainder the same lack places equity and justice at an extreme disadvantage, and prevents the decisions arrived at from being accepted as definitive. The criminal courts decide at most the question of actual possession at the moment: the parties accept the situation for the time, and go away poorer, but not wiser, to renew the contest when opportunity and resources offer. The civil courts work in the dark, sending out "amins" to perform straggling fragments of mapping—the outcome of hearsay and village tradition rather than of any scientific process—which barely serve as precarious foundations for the court's decree, and do not secure the ready identification of the site when the litigation is in course of time reopened. There is nowhere any stand-point of knowledge or certainty, and every transaction in connection with land is either a litigation or a compromise, in which the strongest wins.

But the cleansing of this Augean stable is expected to be a work of extreme magnitude and difficulty. A Commissioner, who is entirely in favour of the experimental introduction of cadastral survey operations, reports that both zamindars who continue to levy rates which have been actually disallowed in courts of justice, and ryots who for years have taken advantage of the absence of a record to hold more land than they pay rent for, are interested in many instances in preventing the truth from being found out, and the appearance of the survey party in any estate will awaken all sorts of fraud and chicanery, all that procrastination, evasion, and quiet opposition at which both zamindars and ryots are such great adepts. To this must be added the opposition which will be offered by interested middlemen of all grades. The cadastral survey will be an opening up of all the sores of the country, a probing of old wounds, and an invitation to all and sundry to come forward and join in the great game of scrambling for rights; for in Bengal there is next to nothing to go upon.

Thus a cadastral survey will not be an unmixed blessing, and there are not a few of the higher officials who think it likely to be exceedingly mischievous, and deprecate its being undertaken. It is strongly opposed by all the more powerful zamindars. Still it is probably more alarming in prospect than it will prove to be in reality. With a view to the acquisition of practical experience on the subject, the Government has ordered a cadastral survey of the district of Mozuffurpur, which lies to the north of Patna, to be immediately undertaken as a tentative measure.

J. T. W.

(*To be continued.*)

AËRIAL NAVIGATION

THE account given in NATURE (p. 421) of the late experiments of the French Government with their "dirigible" balloon is very interesting and important, and in order to give it its full significance I will ask leave to offer a short explanation of the general state of the question.

In 1875 I had occasion, in writing an article on balloons for one of our leading Reviews, to call attention to the fact that some skilful and, so far as they went, successful attempts had been made not long before by two French engineers, MM. Henri Giffard and Dupuy de Lôme, to show the possibility of propelling and guiding balloons through the air.

At that time a general and strong opinion prevailed in England against such a possibility. This opinion was enunciated by various classes of people. In the first place, some writers, taking upon themselves to speak in the name of science, declared that the thing was physically impracticable. The Duke of Argyll, for example, the President of the Aëronautical Society of Great Britain, wrote:—[1]

> "A balloon is incapable of being directed, because it possesses no active force enabling it to resist the currents of the air in which it is immersed, and because, if it had such a force, it would have no fulcrum or resisting medium against which to exert it. It becomes, as it were, part of the atmosphere, and must go with it wherever it goes."

Then another class of objectors were the aëronauts, who necessarily and properly commanded respect as experts in the practice of ballooning. The cleverest of these, Nadar, declared it was impossible to control the direction of balloons, on account of their lightness and large surface, and he laid down what he considered an important principle, that "pour lutter contre l'air, il faut être plus lourd que l'air." One of our most esteemed and experienced English aëronauts, Mr. Coxwell, held the same view; and another (now, alas! lamented) expert, Col. Fred. Burnaby, wrote in the *Fortnightly Review* of May 1884, an article on the "Possibilities of Ballooning," for the express purpose of asserting that the power of guiding them was not one of these possibilities. He professed to show that we were not "one whit nearer" the solution of this problem than when De Rozier and the Marquis d'Arlandes made the first ascent; he denied the truth of the French reports of what had been done; and he offered a present of 100*l.* to any one who, in a free balloon, would after travelling a certain distance return to his starting-point. And I may mention that so strong was the feeling in favour of Col. Burnaby's assertion, that the editor of the *Review* refused to insert a short and respectful remonstrance against it which I tendered to him. Then there were the host of writers in the general Press, the *Times* at their head, who argued that, as in the century since balloons had been invented nothing had been done, it was clear nothing could ever be done, and that the idea of guiding them must be a delusion, which was accordingly ridiculed unmercifully.

All this had an important practical effect; for our military authorities, who wished to make use of balloons in war, totally ignored all possibility of directing them, and confined their attention to using them captive for observing stations, as had been done in the battle of Fleurus nearly a century ago.

As it appeared to me that this opposition and incredulity were very ill-founded, and that the matter was worth more serious investigation, I sent to the Institution of Civil Engineers "A Study of the Problem of Aërial Navigation, as affected by Recent Mechanical Improvements," which they did me the honour to publish in the volume of their *Proceedings* for the session 1881-82. I attempted to show, in the first place, that the problem was perfectly amenable to mechanical reasoning, and that its successful solution involved nothing inconsistent with the teachings of mechanical science; secondly, I pointed out various reasons to account for the failure of early attempts to guide balloons; and thirdly, I showed that the result of the recent French experiments, when treated on ordinary mechanical principles, gave fair data for forming an approximate estimate of what might hereafter be done.

[1] "Reign of Law," London, 1868, p. 130.

They had sufficiently established the general practicability of the attempt, and they had obtained an actual speed through the air of about 6 miles an hour, and it was easy to argue that by suitable provisions this might be increased to 10, 20, or perhaps even 30 miles an hour.

Meantime the French, who had no insular prejudices to restrain them, continued their experiments. M. Gaston Tissandier, an eminent man of science as well as a skilled aëronaut, conceived the possibility of applying electrical power for balloon propulsion; he exhibited a working model at the Paris Electrical Exhibition of 1881, and afterwards made, at his own expense, a large balloon, with which in 1883 he obtained a velocity of 9 miles an hour. But the French military authorities (wiser in their generation than ours) here stepped in, and, with their greater resources, carried the trials still further. They commissioned two of their engineer officers, Messrs. Renard and Krebs, to construct a balloon with which the problem might be thoroughly worked out, and the result is now given. The experiment has been a perfect success; an independent velocity through the air has been attained of upwards of 13 miles an hour; the balloon has been managed, steered, and guided with the greatest ease, and it has, in defiance of the wind, been made to return to its starting-point, the test proposed by Col. Burnaby.

But the most valuable part of the communication to the Academy of Sciences has been the investigation of the bearing of the experiments on the scientific conditions of the problem. There were two points especially which, from the want of actual experience, had in former calculations to be estimated by analogy from water navigation: the resistance which a balloon would encounter at different speeds in its passage through the air, and the efficiency of the screw propeller in overcoming this resistance.

First, as to the resistance. M. de Lôme estimated this by the midship section, but in a vessel much elongated the length has also to be taken into account. Prof. Rankine has given a rule for ships according to the wetted surface, and also another dependent on the displacement. Adapting these to air, and making certain additions which M. de Lôme estimated as special to the balloon, I obtained for the resistance in lbs., the diameter and length being in feet, and the velocity in feet per second—

By the skin friction $R = 0·0000477 dlv^2$;
By the displacement $R = 0·0000886 (d^2l)^{\frac{2}{3}} v^2$.

Now, taking the proportion of MM. Renard and Krebs's balloon at $l = 6d$, these equations become—

$$R = 0·000286 d^2v^2,$$
$$\text{and } R = 0·000292 d^2v^2.$$

The result of the latest French experiments is, when put in English measures—

$$R = 0·000320 d^2v^2.$$

This is a little higher than the estimation by the former methods, but it corresponds sufficiently well to give confidence in the general mode of inquiry.

Secondly, as to the efficiency of the screw propeller. This has been often investigated for water navigation, and it may be said that an efficiency of 70 per cent. is fairly borne out by experience. MM. Renard and Krebs obtain for their screw an efficiency of only about 50 per cent.

It is, I should think, highly probable that by further experience both these elements may be considerably amended; but even taking the facts as they are, they show the attainment of considerably higher speeds to be perfectly practicable. A balloon of 50 feet diameter, for example, would carry power sufficient to give a speed of upwards of 20 miles an hour, and still leave a considerable buoyancy disposable.

At any rate, let us hope that we may have no more quasi-scientific declarations of the impossibility of propelling and guiding balloons, and no more sneers at those who attempt to solve the problem. The capabilities of aërial locomotion of this kind must (as I have fully shown elsewhere) be necessarily limited, but its utility in certain situations would be incontrovertible. The President of the Institution of Civil Engineers, Sir F. Bramwell, speaking in January 1885, said:—

"There may undoubtedly be particular circumstances in which this mode of locomotion would be useful, such, for example, as the exploration of new countries, or as the present Egyptian campaign. I strongly suspect that if our lively neighbours, instead of ourselves, had been invading the Soudan, they would long before this have had a dirigible balloon looking down into Khartoum."

And we have now a curious comment on his words, as we know that at that very time there was, lying in its shed near Paris, a balloon which, though perhaps it could not have saved Gordon, might certainly have saved poor Burnaby, and otherwise have been of incalculable benefit to our military operations. WILLIAM POLE

MEDICAL STUDY IN OXFORD

STATUTES for the regulation of the qualifications of Candidates for Degrees in Medicine and Surgery, and for creating a Faculty of Medicine in the University of Oxford, have after prolonged discussions been approved by Congregation in their definitive form. The Statute which places the medical studies of the University under the control of the new Board of the Faculty of Medicine recently received the final sanction of Convocation, and the other statutes will soon follow. The interest which these Statutes have excited could certainly not be attributed to the radical nature of the changes which they will initiate. It must be rather due to the circumstance that the establishment of the new Faculty is regarded as an indication that Oxford, which has hitherto stood alone as the only University in the United Kingdom which has no mdeical students, and in which there is no organisation for medical instruction, now intends to undertake this function.

It is well known that the Oxford Medical Degree is one of the most coveted professional distinctions, but it does not, like that of Cambridge or Edinburgh, mean that the possessor of it has been trained either in science or in medicine at Oxford. In future there is reason to hope that it will be otherwise—that the University will no longer confine itself to the giving of degrees, but will teach all those branches of medical knowledge which come within the range of University studies.

Chemistry, human anatomy, and physiology, are the three subjects which constitute the scientific foundation of medical education, the last-mentioned being itself founded on the other two. For the instruction of medical students in human anatomy, the University has lately imported from Edinburgh an accomplished and experienced teacher, Dr. Arthur Thomson, who has already as many pupils as he can find room for; and the completion of the new laboratory has rendered possible the development of practical work in physiology. But the mere providing of the means of instruction in these subjects is insufficient, unless the lectures and laboratory work are so systematised as to enable the student to learn all that he needs to learn within the limited time at his disposal, and at the same time each branch of teaching is sufficiently specialised to adapt it to his requirements.

The bearing of the new statutes on medical education in the University can be best understood in relation to the course of scientific training which an intending student of medicine will, if they are passed, be able to follow. Hitherto the Oxford graduate who has obtained honours in biology, has been in no better position as regards his medical curriculum than he would have been had he taken an ordinary pass degree. For the statute now in force, which we hope in a week or two will be replaced by a better, does not permit him to present himself for his medical examination in anatomy and physiology until two years after his degree. In future it will be possible for him to do this at the same time with his examination in the Honour School in the same subjects; the practical effect of the change being that two years will be saved, and that he will be enabled and encouraged *as an undergraduate* to study human anatomy and physiology in their relation to medicine.

In Oxford, as is well known, every man who intends to take a degree in Arts, which is a necessary precursor to that in Medicine, must have passed the examination in classics and mathematics, which is known as "Moderations," and inasmuch as he is not permitted to present himself for this examination until the fourth term after matriculation, it is obvious that he is practically precluded (supposing him to have Medicine in view) from beginning his scientific education until after this period. Consequently, of the four years which intervene between matriculation and his final examination in the Natural Science School, only three at most are at his disposal for the study of physics, chemistry, anatomy, and physiology.[1] Of these three years one at the very least is occupied in acquiring a sufficient knowledge of the four subjects to pass the very thorough and practical "Preliminary Examination." In the scanty remainder of time which is thus left to him he has to get through the most important part of his Oxford work. He has to acquire such proficiency in physiology as will enable him to obtain a class in the Natural Science School, in addition to a very detailed knowledge of human anatomy and a limited acquaintance with organic chemistry. Under present conditions this can only be accomplished by men of exceptional power of work. The rest find it to their advantage to defer their anatomy and chemistry for another year, and consequently are not in a position to enter on their hospital studies until five years after matriculation. As this is more time than men of moderate means can spare, our system cannot be considered satisfactory until the medical student is enabled to devote the four years of University residence entirely to scientific education. The occupation of the first year in studies which, however excellent in themselves, do not fit him for the hard work before him is a grievance of which he may justly claim to be relieved. As, however, the exemption of natural science students from Moderations has already in principle been accepted by Congregation, there can be little doubt that, in the course of a year or two, the desired change will be carried into effect.

The great success of the School of Medicine at Cambridge, although no doubt chiefly due to the ability and energy of the men who are at the head of it, affords evidence that the conditions under which medical education is there conducted, are in themselves well adapted to the requirements of students. It is therefore of interest to compare our own proposed arrangements with those of Cambridge. Assuming that, with the aid of the new Faculty of Medicine, we succeed in giving effect to the views above indicated, there will still be fundamental differences between the two schools.

The first of these is that whereas here every aspirant to the degree in Medicine must have first graduated in Arts, the Cambridge student becomes from the moment that he has passed the "Previous Examination" free to devote himself exclusively to medicine. This of course means that, whereas in Oxford at least four years must intervene between Matriculation and the first examination in medicine, in Cambridge the corresponding point is reached in three years, or even in two,—a loss of time which is chiefly due to the circumstance already referred to, that the year which intervenes between Responsions and the First Public Examination, is by the Cambridge medical student devoted to physics, chemistry, and biology. It is not, however, in this way only that our Oxford system tends to lengthen the course of medical study. Our "Preliminaries," which are adapted to the requirements of an Honour School, are at Cambridge represented by a pass examination in the same subjects, specially intended for medical students, and therefore presumably easier. But it is a point of much more importance that our medical candidate is required, before he presents himself for any medical examination, to have obtained a class in one of the branches of biology. On general grounds there seems reason for thinking that this is disadvantageous, for it does a man harm to compel him to pass an honour examination for, if one may so express one's self, pass purposes. Of the two subjects open to him, the medical student naturally chooses physiology, not only because it is more closely related to medicine, but because he may hope, by obtaining a first or second class, to exempt himself from further examination. In that subject the schedules are framed for the purpose of affording first or second class candidates the opportunity of showing their knowledge. Consequently, in attempting to prepare for it, the medical student who studies physiology specially for the sake of its applications to medicine, acquires a knowledge of wider range than he requires, but of imperfect quality. The evil is a serious one, but happily not difficult to remedy—either by establishing a pass examination in physiology, or, more simply, by marking off in the schedules those subjects which are of less importance to the medical student than the rest.

Enough has been said to show that, however insignificant the position of medicine in Oxford may seem to be at present, it is not likely to remain so. One of the difficulties in the way of medical study here—the non-recognition by the licensing bodies of Oxford teaching—was removed a year ago. The other is the occupation of time, of which the student requires every moment for his preliminary training in physics, chemistry, and elementary biology, with studies which, excellent in themselves, are not conducive to his purpose. From the moment that we are relieved from this drawback, we shall have everything in our favour, and success or failure will depend on our own exertion. In the meantime, it is not too soon to proceed with the organisation of our system of studies, so that, when the opportunity is offered for efficient action, we may be prepared to take advantage of it.

J. B. S.

[1] For more detailed information as to the course of study in Oxford see an article by the writer in the *Oxford Magazine* for January 27, 1886.

CHARLES WILLIAM PEACH

At the ripe age of eighty-six this genial and enthusiastic naturalist has at last passed away. Never was there a more notable example of the irrepressible instinct of a true lover of nature. Born in Northamptonshire, he eventually joined the Coast-Guard service, and was stationed at various parts of the coast where smuggling went on apace and where his shrewdness and tact were often more than a match for the daring spirits who defied the revenue laws. But in the intervals of his duties he found time for close observation of the living things he met with along the shores and of the plants, insects, birds, and fishes he saw inland. Working in the pre-Darwinian days, when the adding of new species to the known list was one of the chief aims of natural history students, his zeal was early enlisted on behalf of the species-makers. Some twenty species and several genera of sponges were first made known by him as inhabitants of our seas. He considerably augmented our list of native hydrozoa and polyzoa. Among the naked-eyed medusæ, echinoderms, mollusks, and fishes he also materially increased our knowledge. One of his distinguishing characteristics was his readiness to tell everything he knew to any naturalist engaged in the investigation of the departments of zoology in which he himself had worked. He was a keen observer rather than a trained naturalist. He published little himself, but he contributed rich materials to those who knew how to make the best use of them. He was consequently a valued correspondent of many of the leading naturalists of his day, who gladly acknowledged their indebtedness to his generous aid. Nor were his observations confined to the living things of the existing creation; he searched the rocks around him for traces of former plants or animals, and found them in places where no one had ever seen or suspected them before. His keen eye detected the first relics of fossil fishes in the Devonian rocks of Devonshire, and when, after his transference to the north of Scotland in 1849, he had an opportunity of looking at the limestones of Durness, he soon brought to light a series of fossils which, in the hands of Murchison and Salter, proved of the utmost value in fixing the geological age of the rocks of the North-West Highlands. After his retirement from the public service he went to reside in Edinburgh, and devoted himself with all his old enthusiasm to the exploration of the fossil flora of the Carboniferous rocks of that neighbourhood. Nothing seemed ever to escape his notice, and hence even from the quarries and sections where many a practised eye had preceded his own he was able to glean materials which no one but himself had noticed. In recognition of his important services to the cause of natural history, the Royal Society of Edinburgh in 1875 awarded to him the Neill Gold Medal. His health has for some time past been failing, and he has now gone to his rest with the affectionate regrets of all to whom the progress of natural science in this country is dear. His son, Mr. B. N. Peach, of the Geological Survey, with all his father's enthusiasm and more than his father's range of acquirement, will, we hope, for many a long year, preserve among the naturalists of this country a family name that is familiar as a household word.

PROFESSOR EDWARD MORREN

CHARLES JAMES EDWARD MORREN, whose death on the 28th ult. we announced in our last issue, was the son of Charles Morren, a Professor in the University of Ghent, and was born in that city in 1833. Shortly afterwards the father removed to Liége as Professor of Botany. The son, Edward, as he was usually called, was educated for the law, but evincing a strong tendency towards the natural sciences and chemistry, took his degree in the Science Faculty with much distinction. Owing to the ill-health of the father, Edward Morren was early called on to undertake the professorial duties, but the continuation of his licence to teach was made conditional on his undergoing a "special" examination for the Doctorate. This was the occasion of the publication of his dissertation on green and coloured leaves, by which he first became known to the botanists of Europe. After the death of Charles Morren, in 1858, the son was appointed in the father's stead, and from that day to this, the aim of the son seemed to be to walk in the steps of his father, and to complete and extend his work. Both devoted themselves not only to botany but to chemistry, and in particular to horticulture and agronomy. Both were imbued, as so many of the Belgian *savants* are, with an ardent patriotism which led them to devote their science to the practical good of the nation, and to hold up to honour and respect the work of their celebrated predecessors. Hence, from father or son, or both, we have memoirs of Dodoens, of de l'Obel, of de l'Escluse, of Fuchs, and other worthies of Flemish nationality.

Both were impressed with the necessity of extending and adapting to the necessities of the times the system and the means of botanical education. The Botanical Institute of Liége, which Edward Morren lived to found and to see completed, was but the modified outcome and extension of the plans and schemes originally proposed by the father. The result is that Liége is now equipped with a compact and well-ordered laboratory for botanical tuition and research, such as some of our own Universities might envy. In order to perfect this institution Morren availed himself of his frequent travels to study the method of instruction followed in the Universities of Germany, and the organisation of the scientific establishments of Holland, Paris, London, and other centres. With his professorial work, his ceaseless duties in connection with official horticulture and the publication of the *Belgique Horticole*, Edward Morren necessarily found little time for the preparation of any separate work, but his memoirs and academic dissertations are numerous. The most important of them, as may be gleaned from what has been said, referred to questions of chemistry and vegetable physiology. A paper published in this country in the Report of the London Botanical Congress, 1866, comprises a most elaborate investigation into the action of sulphurous acid and other vapours on plants.

His academical discourses and popular lectures were remarkable both for their method and their matter. With the fluency and elegance of style of a practised orator, Morren combined the fulness of knowledge and accuracy of exposition of a man of science. Botanists, however, were looking forward with expectancy to a monograph of the Bromeliaceæ from his pen. It was known that the Professor had been accumulating for many years material for this purpose. His collection of living examples is, we believe, the largest and best selected in existence, and the materials in his herbarium and very extensive library (the most complete of its kind in Belgium) are in their way equally remarkable. Beyond detached fragments, however, Morren published little on this curious family.

Death has overtaken him, as it did his father, when little or not at all beyond the prime of life, and it has caused a void which only those who knew the warm-hearted, genial, liberal-minded Professor can fully appreciate.

THE WEATHER

OVER the greater part of the British Islands last month was one of the coldest Februarys on record, the mean temperature at Greenwich being only 33°·8, or 6°·8 below the average of the month. Throughout Great Britain generally, from the Grampians to the Channel, temperature was from about 5°·0 to 7°·0 below the means of the stations. But in the northern and western divisions of these islands temperature was only from about 2°·0 to 3°·5 below the monthly averages. This difference was mainly occasioned by the distribution of temperature during the second week of the month, owing to the higher temperature in the north and west accompanying the storms which prevailed in the far north during the time. Thus during the week ending February 13, the mean temperature of Parsonstown was 43°·5, whilst at Oxford it was so low as 33°·8, or nearly 10° lower.

From the middle of February, however, to the memorable snowstorm in the beginning of March, the weather-maps of Europe presented several remarkably persistent noteworthy features. The commencement of the period was marked at the Ben Nevis Observatory by forty-eight hours of singularly dry clear weather, such as occurs in connection with anticyclones and the settled weather attendant on them. Eastern and Northern Europe was now even more pronouncedly than it had been in the earlier part of the month the theatre of a widely-extended anticyclone, which slowly shifted its position from day to day, and sent out from its central regions winds in all directions, differing much in their climatic qualities. On the other hand, Western and Southern Europe was marked by an atmospheric pressure persistently and greatly lower, with an absence of anything approaching a cyclone—usually a characteristic feature of the weather at this season—if we except a cyclone, not very decidedly marked, that appeared in the Bay of Biscay on February 25, and thence passed slowly eastwards across Italy and Greece, towards Asia Minor, which was reached on March 2.

The inevitable consequence of this distribution of atmospheric pressure was a prevalence of calms and of easterly and northerly winds over the Continent, with low temperatures. For five days, ending February 19, the anticyclone had its centre near Moscow, during which time the barometer, at 32° and sea-level, rose to 30·965 inches. Meanwhile temperature steadily fell, and −7°·6 was recorded at Moscow on the morning of the 19th. The anticyclone thence advanced northward to the White Sea and westward to the Gulf of Bothnia, a pressure of 30·961 inches being recorded at Haparanda on the 22nd, and 30·922 inches at Uleaborg, in Lapland, on the 24th; and thereafter southward to Stockholm with a pressure of 30·603 inches on the 28th, to Riga with a pressure of 30·742 inches on March 1, and to Charkow with a pressure of 30·398 inches on the 2nd. The central regions of the anticyclone were throughout, as happens at this season, marked by unusually low temperatures, the lowest being −16°·8 on the 23rd and −18°·8 on the 24th at Archangel, and −15°·5 on the following morning at Haparanda, these temperatures being about 30°·0 below the average for this time of the year at these places.

The weather-maps show that an important change had already set in on the morning of the last of February, the curvings of the isobaric lines pointing to a cyclone to the north-east of the White Sea, and to another cyclone advancing to the south-west of the British Islands. The anticyclone was thus now surrounded by three cyclones, located respectively near the White Sea, to the south-west of the British Islands, and in the Mediterranean. On the morning of March 1 the most northern of the cyclones had travelled somewhat to westwards, and the other two to eastward; and these respective movements were continued on the following day. In the meantime the anticyclone had greatly shrunk in breadth, and by the morning of the 2nd, when the snowstorm raged most fiercely over an unusually extensive breadth of country, it lay as a narrow tongue of high pressure westwards over Scandinavia, and, meteorologically considered, perilously close on to the cyclone whose centre was then about the Humber. It necessarily followed, from the contiguity of the high-pressure area to the cyclone on its north side, that the storm passed across the British Islands with uncommon slowness, thus prolonging its continuance in Great Britain; and that the steepest gradients were formed in the north-east quarter of the cyclone,—a rather unusual feature of the storms of North-Western Europe,—thus exposing North Britain to one of the worst easterly gales of recent years.

Some snow fell in a few places on Sunday, but on Monday it fell in almost all parts of England, the fall being particularly severe in North Wales and the northern counties. The Furness and Wigtownshire railway lines were blocked and traffic suspended, a circumstance that has not occurred since these railways were opened, which as regards the Furness line is twenty-seven years ago. In the more southern counties the storm was not quite so severe, and as the day advanced the snow changed to sleet and at last to heavy rain. On the Tuesday the storm spread northwards over all Scotland, and raged with a fury altogether unexampled. Owing to the fineness of the snow-particles and the force of the wind, snowdrifts in many places accumulated in a degree quite unparalleled, and all transit was seriously paralysed. The most serious railway block occurred on the East-Coast line, and it was computed that thirty trains of various sorts were snowed up between Newcastle and Berwick. Letters carried by the London Monday mail were not delivered in Edinburgh till Friday morning. The sensation produced by the rapidly-driven snow-particles on the face resembled the sharp pricking of a shower of needles; and it was remarked that the effect of the snow-drift on the eyes gave the feeling which would be produced by the spray of dilute nitric acid. As respects the singular character of the snowfall, it may be suggested that it was in some way connected with the remarkable meteorological conditions described above as having overspread Eastern and Northern Europe during the fortnight preceding the storm, and the proximity of North Britain to the anticyclone when the storm raged in all its fierceness.

It is remarkable that, while the snowfall was large in many western as well as in eastern districts, it was comparatively light over the higher midland parts of Scotland, and that on Ben Nevis and surrounding mountains little snow fell. It is to be noted, however, that at the Ben Nevis Observatory the wind blew, not as is usual on such occasions, from a different direction, but from precisely the same direction as at lower levels, with a force, however, very greatly diminished, the mean wind-force for the day being estimated by Mr. Omond at only 4 of the Beaufort scale. For the week preceding the storm the mean pressure and temperature of the air at the Observatory were respectively 25·482 inches and 14°·9; and at sea-level at Fort William, 30·154 inches and 33°·2. This mean pressure at the Observatory is 0·046 inch in excess of what previous observations show to be the mean when the sea-level pressure and temperature of the air is as above. On the morning of the storm the excess was double that of the previous week. It is these departures from the average in their relations to the cyclones and anticyclones of this part of Europe that give the Ben Nevis observations their great significance.

NOTES

It will be remembered that the Paris Academy of Sciences on Monday week, after hearing Prof. Pasteur's account of the cases he has treated, appointed a Committee to consider the question of the establishment at Paris of a vast international hospital. On Monday last M. Vulpian communicated to the Academy the following proposals, unanimously agreed upon by the Committee:—(1) An establishment for the treatment of rabies shall be founded at Paris under the name of l'Institut Pasteur. (2) This Institution shall be open both to French subjects and to foreigners bitten by dogs or other rabid animals. (3) A public subscription is opened in France and abroad for the foundation of this establishment. (4) The employment of the funds subscribed shall be made under the direction of a Committee, consisting of Admiral Jurien de la Gravière, President of the Academy of Sciences; M. Bertrand, M. Vulpian, M. Marey, M. Paul Bert, M. Bichat, M. Charcot, M. Hervé Mangon, M. de Freycinet, M. Camille Doucet, M. Wallon, Vicomte Delaborde, M. Jules Simon; M. Magnin, Governor of the Bank of France; M. Christophile, Governor of the Crédit Foncier; M. Alphonse de Rothschild; M. Beclard, Doyen of the Faculty of Medicine, and Perpetual Secretary of the Academy of Medicine; M. Brouardel, Professor to the Faculty of Medicine, and President of the Consultative Hygienic Committee of France; M. Gaucher, Professor to the Faculty of Medicine of Paris. (5) The subscriptions shall be received at the Bank of France and its branches, at the Crédit Foncier and its branches, and at the Public Treasury Offices. The names of all subscribers shall be inserted in the *Journal Officiel*.

THE Stockport people have a pleasantly hearty way of testifying their appreciation of the services of scientific men. A series of popular science lectures has been given this winter under the auspices of the local Society of Naturalists and the directors of the Mechanics' Institution. The fourth of the series was on "The Life of Pasteur," and on the conclusion of the lecture it was proposed from the body of the hall that an address of thanks should be sent to the illustrious Frenchman. In accordance with the resolution an illuminated memorial has been prepared for transmission to M. Pasteur.

M. CHEVREUL has so far recovered that he has been able to walk out in spite of the low temperature prevailing in Paris.

SIR JOHN LUBBOCK has been appointed Rede Lecturer to the University of Cambridge for the ensuing year.

M. CORNU, member of the Paris Academy of Sciences and Professor in the Polytechnic School, has been appointed a member of the Bureau des Longitudes.

THE Council of the St. Petersburg University has awarded Prof. P. A. Tlienkoff's premium of 500 roubles to Prof. P. T. Brounoff of the same University for his work on "The Laws of the Movement of Cyclones and Anticyclones, especially in Russia." For the next year's competition the same premium is offered for the best work on the Compositæ of European Russia.

THE late Dr. Davidson had a world-wide reputation as one of the most eminent of British palæontologists, and freely gave his life-long services for the advancement of science. He also rendered, for a series of years, great and valuable services to Brighton; chief amongst which may be mentioned the arrangement of the Brighton Free Museum in its present *locale*, the presentation to it of a fine series of volcanic products, and of his collection of rocks and fossils from the Paris Basin—one that is unique of its kind and of very great value because it was obtained whilst the fortifications of Paris were being constructed, an exceptional circumstance not likely to recur; in addition to these the late Dr. Davidson acted as Chairman of the Museum Committee for several years, and filled that office at the date of his death. Whilst holding this position his attention to and care over the best interests of that institution were unremitting, and he was always ready, at his own expense, to purchase specimens for the public benefit, whenever he thought it desirable to fill up gaps in any series in the museum, on behalf of which his scientific influence was always freely exercised. It is felt that such disinterested and valuable services should be permanently commemorated in the museum in which Dr. Davidson laboured so assiduously and which he loved so well. With this end in view, the Mayor of Brighton, Mr. E. J. Reeves, on behalf of the members of the Pavilion Committee of the Town Council, and of the Museum, Fine Arts, and Library Committees, invites his fellow-townsmen and Dr. Davidson's personal and scientific friends to contribute towards the raising of a fund to be devoted to the placing in the museum of a memorial to the late Dr. Davidson.

THE Royal Meteorological Society's Exhibition of Barometers will be held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Tuesday and Wednesday next. The Exhibition will be a most interesting one, as a large number of various forms of barometer have been brought together, many of them being of great value, and some being the only specimens known to exist. At the meeting of the Society on Wednesday evening, the President, Mr. W. Ellis, will give an historical account of the barometer. Any persons, not Fellows, wishing to visit the Exhibition or to attend the meeting, can obtain tickets on application to the Assistant Secretary, Mr. W. Marriott, 30, Great George Street, S.W.

OF the three colleges—Columbia, Harvard, and University of Pennsylvania—that received the benefit of the Tyndall Fund, Columbia has been the first to act, we learn from *Science*. Her trustees have recently drawn up a series of regulations in regard to the John Tyndall Fellowship. The Fellow, who is to be appointed on the recommendation of the President and Professors in the Scientific Department, must pursue a course of study and research in experimental physics for the term of one year, and he may be reappointed. The first incumbent of the Fellowship is Michael Pupin, who graduated at Columbia in 1883 with honours, and has since his graduation been studying mathematics and physics at Cambridge, England.

M. GUERAULT, the well-known electrician and secretary of the *Lumière Électrique*, has died, at the age of forty, from consumption. He was well known in England, where he stayed during some years to learn engineering.

A VERY interesting entomological conference took place recently at Odessa; it was organised by the Zemstvos of nearly all the southern provinces of Russia. It appears from the reports read by the respective representatives, that nearly all the southern districts of Russia suffer more or less from different obnoxious insects and other animals, but principally from the Hessian fly and marmots. The latter are especially destructive to the corn-fields, and the Zemstvos found themselves compelled to encourage the extermination of the plague by offering a reward of from one to three kopeks (one to three farthings) for each animal killed. During the year 1885 alone the Zemstvo of Kherson thus paid over 100,000 roubles, this sum corresponding to 6,600,000 animals killed, while in 1883 over 2,000,000 of these animals had been killed.

MR. WESTWOOD OLIVER, with the assistance of Messrs. E. W. Maunder, F.R.A.S., W. F. Denning, F.R.A.S., T. E. Espin, F.R.A.S., A. Cowper Ranyard, F.R.A.S., T. Gwyn Elger, F.R.A.S., J. E. Gore, F.R.A.S., J. Rand Capron, F.R.A.S., Howard Grubb, F.R.S., F.R.A.S., W. S. Franks, F.R.A.S., T. W. Backhouse, F.R.A.S., and other well-known observers, has in preparation a practical manual of "Astronomical Work for Amateurs," the aim of which is to help the possessors of limited instrumental means to turn their attention to astronomical researches of real scientific utility, special attention being directed to the comparatively new fields of spectroscopy and celestial photography. The book will be published by Messrs. Longmans and Co. Mr. Oliver invites suggestions from practical workers, which may be sent to him at Lochwinnoch, Scotland.

WE have received Parts I. and II. of "British Petrography, a Description of the Ordinary Rocks of the British Isles," by J. J. Harris Teall, F.G.S. The publishers are Watson Brothers and Douglas, Birmingham.

ON March 15, 22, and 29, Prof. Bonney lectures at the London Institution on the "Making of Mountains."

THE Arago Laboratory created by M. de Lacaze-Duthiers in France is attracting much attention on the Continent. This laboratory serves as a counterpart to that formed at Roscoff, and is performing an excellent work. It is constructed in such a manner as to be capable of resisting excessive heat, which always militates considerably against the operations carried on at this and all similar laboratories.

THE artificial reproduction of the sole is being energetically carried on in France, where a laboratory was established so far back as 1881 by Dr. Joussett of Belleyme especially for this purpose. Since that time the ova of the sole have been regularly incubated with success, notwithstanding the numerous difficulties attending the process.

The French Consulting Committee of Hygiene recently advised the prohibition of the use of vaseline for butter in food preparations. The effects of vaseline on the system, however, seemed to require fuller examination, and Dr. Dubois has made some experiments in regard to it. Two dogs were fed exclusively on soup in which the usual fat was entirely replaced with vaseline; one of them absorbed 25 grammes of vaseline a day for ten days, the other 15 grammes (this would correspond in the case of an average man to 100 grammes and 60 grammes respectively). With this diet the animals even slightly increased in weight. Their general state was good: there was no loss of appetite, nor vomiting, nor diarrhœa. In general it may be said that the carburets of hydrogen forming vaseline, though they favour neither oxidation nor saponification like fats, are readily tolerated in the alimentary canal, at least in the case of dogs. Further experiments will show if a prolonged use of the substance is equally innocuous.

It is estimated by the Marquis de Nadaillac (*La Nature*), that Europeans can endure temperatures as widely apart as 130° C. at least. Thus, on January 25, 1882, a temperature of − 65° C. was recorded on board the *Varna* and *Dijmphna*, when blocked by ice in the Sea of Kara, east of the Straits of Waigatz. On the other hand, M. Duveyrier, in the country of the Touaregs, in Central Africa, has seen the thermometer rise to 67°·7 C.

A recent number of *Globus* contains an article by Prof. Nehring, on an interesting prehistoric discovery made in the neighbourhood of Madgeburg. At the village of Westeregeln, between that city and Halberstadt, in the course of some work the labourers came on the remains of an ancient grave, containing parts of the skeleton of an unburned human body, near which were about 112 bored dogs' teeth, two decorated shells of a river shell-fish now only found in Southern Europe, the *Unio sinuatus*: two pieces of an easily-burnt resin, the remains of one or more clay vessels, and a small highly-oxidised bronze ring, which appears to have been used as a finger ornament. The teeth, from their formation, must have been collected from twenty dogs at least, and they were all bored through the root portion, and were evidently meant to be hung on a string. With reference to the shell, it is noticeable that here and there in the Rhine provinces similar shells are found with Roman remains. Dr. Nehring is inclined to look for an explanation of this circumstance rather to an importation from Southern Europe than to the theory that the *Unio sinuatus* has died out since the Roman period in the Rhine provinces. Ornaments of the teeth of Carnivora for the neck, waist, arms, &c., have been found in prehistoric mounds or graves elsewhere in Germany; and even now they are in use for a similar purpose amongst certain primitive peoples. The Igorrotos of Luzon use them for necklets and earrings; so also do the inhabitants of the islands in Torres Straits.

At the annual meeting of the London Sanitary Pro'ection Association the Report stated that the number of members is now over 1000, and the total number of inspections made during the year 1264; a large number having been made in the suburbs of London and several in the country, including that of Eton College and other large public institutions. Unfortunately the general character of the houses inspected was as insanitary as ever, only 5 per cent. being found in perfect order, and 9·5 per cent. in fairly good order; whilst in 60 per cent. foul air was escaping directly into the house, and in 24 per cent. sewage was partly retained underground by leakage or choking of pipes.

Dr. Schliemann, who has been busy at Berlin for the last few days arranging in the new Ethnological Museum the fruits of his recent excavations, intends to return to Athens shortly. The doctor promises that Berlin shall be the ultimate inheritor of all his archæological treasures.

A telegram from Catania announces Mount Etna to be in a state of eruption. Cinders and stones are being continually thrown up, and it is supposed that lava is coming out of the crater, but as it is covered by a dense mist no proper observations can be taken. Slight shocks of earthquake have been felt at the foot of the mountain.

A violent shock of earthquake was felt at 7.30 on Saturday morning at Cosenza. Several houses were thrown down. One person was killed.

The additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas* ♀) from West Africa, presented by Master Eric Blind; a Toque Monkey (*Macacus pileatus*) from Ceylon, presented by Mr. C. Brown; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Lieut. W. H. Duffin, King's Own Regiment; a Serval (*Felis serval* ♂), a White-tailed Ichneumon (*Herpestes albicauda*) from West Africa, presented by Mr. F. J. Jackson; a Canada Goose (*Bernicla canadensis*) from Canada, presented by Mr. J. E. Kelsall; a Rough-billed Pelican (*Pelecanus trachyrhynchus*) from Mexico, a Hutchins's Goose (*Bernicla hutchinsi*), from Arctic America, purchased.

OUR ASTRONOMICAL COLUMN

Lunar Inequalities due to the Action of Jupiter.—Some years ago Prof. Newcomb, discussing certain discordances between the observed and tabular places of the moon, was led to the conclusion that there existed a hitherto undetected inequality with a coefficient of 1″·5 in the longitude, and having a period of about 17 years as regards its effects on the eccentricity and longitude of the perigee. Shortly afterwards Mr. Neison announced that he had found in the action of Jupiter the explanation of this inequality. Using Delaunay's notation, his expression for the inequalities in longitude is—

$$\delta V = -1''\cdot163 \sin(2h + 2g + l - 2h'' - 2g'' - 2l'') + 2''\cdot200 \sin(2h + 2g - 2h'' - 2g'' - 2l'').$$

Now, the coefficient of the second of these inequalities is, theoretically, a quantity one order higher than that of the first; the first having the simple power of the eccentricity as factor, while the second has the square. Hence we should naturally expect to find the latter coefficient the smaller. On the grounds, therefore, that there is reason to think that Mr. Neison's value of this coefficient is possibly too large, Mr. G. W. Hill has investigated the lunar inequalities arising from the action of Jupiter, and has computed afresh the values of the coefficients of the resulting perturbations in longitude. His final result is—

$$\begin{aligned}\delta V = &-0''\cdot903 \sin(2h + 2g + l - 2h'' - 2g'' - 2l'')\\ &+0''\cdot209 \sin(2h + 2g - 2h'' - 2g'' - 2l'')\\ &-0''\cdot118 \sin(l - 2h' - 2g' - 2l' + 2h'' + 2g'' + 2l'').\end{aligned}$$

It will be seen that the coefficient of the second term is only about one-tenth of that found by Mr. Neison. It is not possible at present to determine the cause of this discordance, as Mr. Neison has not published the details of his investigation. It is to be hoped that he will now do so, in order to afford the means of deciding this interesting matter.

Spectroscopic Determination of the Motion of the Solar System in Space.—The *Astronomische Nachrichten*, No. 2714, contains a brief note by Herr Hans Homann, giving the result of a discussion he has recently made of the spectroscopic observations of the motions of stars in the line of sight made at the Royal Observatory, Greenwich. He finds the position of the apex of the solar motion as derived from these to be R.A. 320°·1, Decl. 41°·2 N., and the speed of translation to be 39·3 ± 4·3 kilometres per second. He has likewise discussed the similar observations made by Dr. Huggins, and at the Temple Observatory, Rugby, by Mr. Seabroke, although these two latter series embraced too few stars, and these insufficiently observed to furnish adequate grounds for any satisfactory conclusions. The results derived from these three series, though differing very considerably from each other, yet show a certain rough correspondence which was perhaps all that could be expected, and Herr Homann considers that the velocity of translation may be taken as not greatly differing from 30 kilometres a second. The results from Dr. Huggins's and Mr. Seabroke's measures are as follows:—

Observer	Velocity of Translation km. per sec.	Apex of Solar Motion
Huggins ...	48·5 ± 23·1 ...	R.A. 309°·5, Decl. 69°·7 N.
Seabroke ...	24·5 ± 15·8 ...	R.A. 278°·8, Decl. 13°·6 N.

These results all differ very considerably from those obtained by Struve, Airy, Galloway, and others, from a consideration of the proper motions of stars as observed with the telescope, *i.e.* in a direction at right angles to the line of sight, the most probable mean value of the co-ordinates of the apex from all these discussions being about R.A. 260°, Decl. 35° N., whilst Struve found the velocity of translation to be about 7 kilometres per second. This speed was, however, based upon the assumption that the average annual parallax of stars of the first magnitude is about 0"·25, and it should be borne in mind that Airy obtained (*Mem. R.A.S.*, vol. xxviii. p. 161) from the discussion of 113 stars with large proper motions a speed of translation nearly six times as large as that of Struve. Plummer also (*Mem. R.A.S.*, vol. xlvii. p. 341), from a rediscussion of Galloway's data, found for the co-ordinates of the apex R.A. 276° 8', and Decl. 26° 31' N., a result which differs considerably from the earlier ones above referred to, and in the direction of greater accordance with those obtained by the spectroscopic method. It may, however, be doubted whether the spectroscopic results are yet ripe for satisfactory discussion; the preliminary investigation undertaken by Plummer some time ago gave distinctly disappointing results, and, so recently as last May, Maunder (*Observatory*, vol. viii. p. 165) stated that but "some fifty stars in all had been observed a sufficient number of times for us to be able to deduce their speed to the nearest ten miles per second." He considered, however, that the results, so far as they went, "indicated a motion towards α Aquarii rather than towards any point in Hercules." This would agree well with Herr Homann's calculations in R.A., but not in Decl.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *MARCH* 14-20

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 14

Sun rises, 6h. 17m.; souths, 12h. 9m. 19·2s.; sets, 18h. 1m.; decl. on meridian, 2° 26' S.: Sidereal Time at Sunset, 5h. 30m.

Moon (one day after First Quarter) rises, 11h. 20m.; souths, 19h. 14m.; sets, 3h. 6m.*; decl. on meridian, 18° 14' N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° '
Mercury ...	6 39 ...	13 6 ...	19 33 ...	4 33 N.
Venus ...	4 40 ...	10 3 ...	15 26 ...	7 57 S.
Mars ...	16 35 ...	23 32 ...	6 29* ...	10 27 N.
Jupiter...	18 37* ...	0 44 ...	6 51 ...	0 37 N.
Saturn...	10 26 ...	18 38 ...	2 50* ...	22 47 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable-Stars

Star	R.A. h. m.	Decl. ° '		h. m.	
U Cephei	0 52·2 ...	81 16 N. ...	Mar. 18,	19 55	*m*
Algol	3 0·8 ...	40 31 N. ...	,, 18,	4 18	*m*
ζ Geminorum ...	6 57·4 ...	20 44 N. ...	,, 15,	0 0	*M*
			,, 20,	4 50	*m*
S Cancri	8 37·4 ..	19 27 N. ...	,, 17,	1 10	*m*
T Ursæ Majoris ...	12 31·2 ...	60 7 N. ...	,, 14,		*M*
δ Libræ	14 54·9 ...	8 4 S. ...	,, 18,	21 44	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 16,	4 46	*m*
W Scorpii	16 5·1 ...	19 50 S. ...	,, 16,		*M*
U Ophiuchi	17 10·8 ...	1 20 N. ...	,, 14,	23 15	*m*
		and at intervals of		20 8	
X Sagittarii	17 40·4 ...	27 47 S. ..	Mar. 17,	0 0	*m*
			,, 19,	21 40	*M*
W Sagittarii ...	17 57·8 ...	29 35 S. ...	,, 18,	21 30	*m*
β Lyræ	18 45·9 ...	33 14 N. ...	,, 18,	21 40	m_2
η Aquilæ	19 46·7 ...	0 7 N. ...	,, 17,	19 10	*M*
T Cephei	21 8·0 ...	68 2 N. ...	,, 14,		*M*
δ Cephei	22 24·9 ...	57 50 N. ...	,, 19,	2 20	*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
14 ...	B.A.C. 1930 ...	6½ ...	0 40 ...	1 28 ...	152 279
15 ...	1 Cancri	6 ...	22 15 ...	23 12 ...	70 327
18 ...	37 Sextantis ...	6 ...	17 25 ...	18 17 ...	11 240
20 ...	B.A.C. 4043 ...	6½ ...	1 38 ...	2 34 ...	119 239

March	h.	
15 ...	6 ...	Mercury at least distance from the Sun.
20 ...	... ...	Sun in equator.
20 ...	8 ...	Jupiter in conjunction with and 0° 13' north of the Moon.

GEOGRAPHICAL EDUCATION AND NATURAL SCIENCE [1]

ONE of my claims to address you on the subject of geographical education is that I have been a traveller. In my opinion nothing can better bring home to the mind the value of good geographical instruction, or make more keenly felt the disadvantages of the lack of it, than a scientific journey round the world. It is naturally the scientific side of geography which interests me most; and it is on the importance and prospects of physical geography as a subject of education that I have now to speak.

To the naturalist a knowledge of physical geography is becoming yearly more and more essential. The geographical distribution of plants and animals is one of the most important and fascinating of all the branches of his subject, presenting an immense field for research, full of problems of the utmost interest. Such problems can only be approached, with hope of success in elucidating them, with a clear comprehension of the principles of physical geography, and a power of entering into the utmost details whenever required. The distribution of organisms, and often their very forms and existence, are the result of the relative positions of the various climatic and other physical barriers on the earth's surface. On the land surfaces, where these barriers present most sharply-defined and serious obstacles to migration, the complexity of the distribution of the terrestrial fauna and flora is most remarkable. On the shores, where the barriers are less complete, the isolation and geographical restriction of the littoral fauna and flora is less developed. Whilst in the ocean, with no absolute land-barriers, the pelagic fauna shows little more than a distribution of animal and vegetable forms, according to climatic zones. In the depths of the ocean, which the effects of climate do not reach, the distribution of the animal inhabitants almost approaches universality.

It is, however, scarcely necessary to insist on the especial importance of the study of physical geography as one of the bases required for the scientific pursuit of zoology; and I am sure no one will be more ready than my friend Sir Joseph Hooker, to whom our knowledge of the geographical distribution of plants, and its meaning, is so largely due, to testify to its immense importance in the case of botany. It is obvious that it is equally indispensable in the cases of geology, astronomy, and meteorology.

Far more important is the question, Ought not physical geography to form part of every liberal education, as being a subject specially adapted for purposes of general learning, and as the only true basis on which can be founded a knowledge of what is termed political geography? Political geography may be regarded to some extent as the geographical distribution of mankind; and its various features of importance—its boundaries, its lines of migration and commerce, its cities and battle-fields—have their positions determined by the physical conditions and conformation of the earth's surface, as much as in the case of the distribution of the lower organisms.

In Germany and Austria, and many other parts of Europe, the necessity of physical geography as a subject of general education and of higher University study seems to be thoroughly accepted. There can be little doubt that it is an excellent subject of general education. I have become more and more convinced of this from my own experience as an examiner in the subject, and especially when examining for the Public School medals of this Society.

[1] Abstract of Lecture by Prof. H. N. Moseley, F.R.S., at the Royal Geographical Society's Exhibition of Geographical Appliances, Sir Joseph Hooker, K.C.S.I., V.P.R.S., in the chair.

Dr. Archibald Geikie, than whom no one can speak with higher authority, has expressed a most decided opinion on the peculiar value of physical geography in education. He writes, in a letter published in Mr. Keltie's excellent Report, that he knows of no other subject "that lends itself so effectively to the teacher who wishes to inspire his pupils with some appreciation of the nature and value of scientific education and reasoning." He has long been of opinion that, in this sense of the term, geography (that is physical geography), should form an essential part of education.

It seems generally conceded that the teaching of geography in this country is at present in a very unsatisfactory condition, and far behind that existing over a great part of the Continent of Europe. It is most remarkable, and much to be regretted, that in England, of all countries where advanced education prevails, with her world-wide possessions and interests, such a condition should exist. There can be no doubt about the matter. The fact that it is not found by English publishers to pay to issue first-rate maps and works on physical geography, equivalent to those published in Germany, is striking evidence of its correctness. The present movement is founded on a conviction that it is so. The reasons for this condition of things are probably not far to seek. When we find that geography, whether in lower or higher schools, or at military training colleges, is best taught and provided for in such countries as Germany and Austria, where the subject is represented by special professors and systematically taught at the Universities, whilst at no British University is there any professor of geography at all, it is surely not unreasonable to conclude that the lack of professors and higher teaching of the subject at our Universities is the main cause of the inferior position of the subject here.

The present energetic effort of the Society to promote geographical teaching cannot but yield considerable results in improving the position of the subject in this country, but it is most important that a further attempt to introduce the subject in any form, as a University one, should be made.

Possibly, although at the present moment it may not be feasible to secure the representation of geography as a whole, because of the apparent vagueness of its bounds and the attacks on all sides to which it is in consequence liable, there may be a chance of success if the attempt be made to press the claims of physical geography. It is, however, scarcely possible that the establishment of physical geography at the Universities can ever be effected without the cordial co-operation of the leading geologists of this country. I know that several of these, including Prof. Bonney, to whom I am indebted for much advice in the present matter, believe that the time has come when special chairs of physical geography should be established, regarding the question as one of, as it were, splitting the subject of geology into two parts. Prof. Archibald Geikie expresses himself as of a similar opinion in his letter published in Mr. Keltie's Report. That there is a necessity for lectures on the higher branches of physical geography is shown by the fact that courses of lectures nearly relating to this subject are now being given by Prof. Hughes at Cambridge and Prof. Boyd Dawkins at the Owens College, and I venture to suggest to the Council of the Society that it would be well to make an attempt to secure the co-operation of the Geological Society in a joint endeavour to induce the Universities to establish professorships of physical geography. There are many reasons why success may attend an effort to establish the representation of physical geography rather than the wider subject. It is obvious that any professor who could hold such a chair must be a geologist, the two subjects of physical geography and geology being most closely allied and overlapping. I am not going to attempt to define physical geography as a subject. The term geography is, no doubt, a somewhat unfortunate one, and a great deal of serious opposition has been raised to the advancement of the subject on such grounds as that it is a "graphy" and not a "logy." But the Germans have not only practically separated geology and geography as subjects of University study with the highest success, but find no difficulty in the use of the term physical geography to cover such knowledge as is represented in Peschel's excellent work, "Allgemeine Erdkunde."

Regarding physical geography as a part of geology to be separated from it:—The reason why such a separation should be effected is that there is thus formed and brought together for special treatment a subject which is far more necessary and suitable for general educational purposes than the whole of geology itself, which will attract far more students and act as a lever for promoting the study of other branches of science as special subjects, as well as of geology itself.

The principal argument that is always brought against the establishment of professorships of physical geography at the Universities, is that the subject is already covered by the professors of geology; but Prof. Geikie evidently does not take that view, and points out in his letter already referred to, "Geology is every day increasing in its scope, which is already too vast for the physical powers of even the most indefatigable teacher." It is already impossible for one teacher to cover all which may be supposed to be included under the name geology. When both physical geography and geology are represented by a single professor in a University they must needs be inadequately covered, or one branch must receive but meagre treatment in proportion to the other; or the period covered by a course of lectures is too long for any one student to attend the whole. Convinced that it is a matter of the utmost importance for the progress of geography here to show that the two subjects, geology and physical geography, can be taught with perfect harmony and advantage by different professors at the same time at a University, I asked Mr. Keltie to write to some of the German professors of geography, and request them to express their views on the matter, and to ask for copies of the syllabuses of courses of lectures on geography and geology delivered at the same time within their Universities. He has handed me the following most interesting letter from Prof. Kirchhoff, Professor of Geography at Halle:—

"Unfortunately, I cannot send you syllabuses of the University lectures in geology like those of my own lectures on general geography, and on the countries of Europe, which I placed in your hands, since such do not exist.

"However, the question now being raised in England is already practically settled in Germany. All the Universities in Northern Germany, and now those in Austria also, possess geographical as well as geological professors, and it is not found in any instance that the two interfere with each other, or are superfluous to each other, but, on the contrary, they have proved to afford mutual support.

"It is, no doubt, correct that geology, in just the same way as geography, is concerned with the earth and all its various parts. But the point of view on either side is different. For example, whilst I am delivering in Halle during four successive semestres the course on geography, with the nature of which you are acquainted, Prof. von Fritsch and two colleagues are lecturing to almost entirely different audiences on mineralogy, crystallography, geology, and palæontology. In summer, Prof. von Fritsch arranges excursions for geological purposes, and many of the students attending my lectures take part in these, because a problem of great geographical importance is able to be solved during these excursions, namely, the explanation of the form of the land surface as resulting from its composition, and by means of the history of its development.

"The two sciences do, indeed, touch one another in what is termed superficial geology, but from this zone of contact they stretch wide apart from one another. Geology discusses not only the developmental history of the earth in the Quaternary period, a matter which concerns the geographer quite as much as the geologist, but it discusses also that of the most remote periods of the earth's antiquity, investigates the petrographic structure and the organic life of every formation, subjects which hardly concern the geographer at all.

"On the other hand, geography has to deal not only with the land surface and the waters, but also with climate, the flora and fauna, and human inhabitants, both of the earth as a whole and of each separate country, confining its view to the present only, that is to say to the Quaternary period. It might as well be said that the existence of history as a subject at Universities rendered geography unnecessary, because it also has to do with the entire earth's surface.

"In reality, geography embraces all facts relating to the earth, borrowing them often from other sources. The geology of the British Islands, for example, together with their history since the time of Cæsar, does not by any means represent the geography of the islands."

Prof. Wagner, of Göttingen, Professor of Geography in that University, a most eminent authority on geographical education, has sent a note, in which he gives a syllabus of his own lectures and those of Prof. von Koenen, Professor of Geology.

From this it is evident, as Prof. Wagner concludes, "that there is no connection whatever (*gar kein Konnex*) between my lectures and those of the geologist."

Can any one doubt that the establishment of such a system of teaching geography and geology, side-by-side, as set forth in these two communications, would not be of the utmost benefit to our country and its education generally, if established in our Universities also? It will be impossible to obtain adequately trained teachers of physical geography until such courses of instruction are open; and until adequately trained teachers are produced for higher schools and training colleges, no real progress in the teaching of physical geography can be made throughout the country.

There can scarcely be a doubt that the establishment, at our Universities, of such a condition as that at the German ones, would be in every way to the advantage and advancement of geology, and to the increase of the numbers of its students; it would also advance the cause of all other branches of natural science, and all interested in the teaching of these subjects ought to support a movement in favour of its adoption warmly. No doubt the adoption of the system is merely a question of time,—England cannot lag behind in the study of geography for ever.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. J. E. Marr, M.A., Fellow of St. John's College, has been appointed University Lecturer in Geology.

It is estimated that the ethnological collections now displayed in the Antiquarian Museum are worth at least 2000*l*., and with a little additional accommodation objects valued at 1000*l*. more can be displayed. These series are of inestimable value to the student of anthropology, and from the labours of Baron von Hügel in their arrangement the University is reaping a rich harvest. The baron contemplates illustrating them by a full series of maps and drawings.

The honorary degree of M.A. is to be conferred on Mr. C. Todd, Government Astronomer, Postmaster-General, and Director of Telegraphs in South Australia.

The Open Entrance Scholarships for Natural Science to be competed for in the ensuing months include those of Peterhouse, Chemistry and Physics, October; Clare, Natural Science, March 24; Downing, Natural Science, June 1; Non-Collegiate Students, Physical Science, July.

Mathematical Scholarships will be given at each College mentioned above (except Downing), and at Trinity Hall, March 17; Corpus Christi, March 23; Queens', April 27; St. Catherine's, May 11; Magdalene, March 17. Further information will be given by the Tutors of each College.

AT the City and Guilds of London Institute, Central Institution, Exhibition Road, S.W., Prof. Ayrton, F.R.S., will give a course of six lectures on some of the industrial applications of electricity, from 5 p.m. to 6 p.m. Friday afternoons, March 12, 19, 26, April 2, 9, and 16. The lecture on March 12 will be on Electric Lighting; March 19, Electricity as a Motive Power; March 26, Electric Storage of Energy; April 2, Electric Transmission of Power; April 9, Electric Meters; April 16, Electric Locomotion.

AT Clifton College a Scholarship of the value of 30*l*. per annum, tenable for three years at the Central Institution of the City and Guilds of London Institute for the Advancement of Technical Education, is offered by the Committee of the Institute, and will be awarded, on the nomination of the headmaster, in July next. The candidate so nominated will be required to pass the Entrance Examination of the Institution, to be held in the following October. It is the intention of the Committee of the Institute to offer this Scholarship annually for six years, beginning with 1886. The object of the Central Institution is to provide advanced instruction in those kinds of knowledge which bear upon the different branches of industry, whether manufactures or arts.

It is intended that a subdivision of the Military and Engineering Department of Clifton College shall have its studies specially, though not exclusively, directed with a view to prepare for entrance to the Central Institution and similar Engineering and Technical Colleges.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 4.—"On the Polarisation of Light by Reflection from the Surface of a Crystal of Iceland Spar." By Sir John Conroy, Bart., M.A. of Keble College, Oxford. Communicated by Prof. G. G. Stokes, P.R.S.

In the year 1819 Sir David Brewster communicated to the Royal Society (*Phil. Trans.*, 1819, p. 145) an account of some experiments he had made on the polarisation of light by reflection from the surface of double-refracting substances, and showed that Malus's statement with regard to Iceland spar was incorrect.

Malus said that Iceland spar behaves towards the light it reflects like a common transparent body, and that its polarising angle is about 56° 30′, and that, whatever be the angle comprehended between the plane of incidence and the principal section of the crystal, the ray reflected by the first surface is always polarised in the same manner ("Théorie de la Double Refraction," pp. 240, 241).

Some years later Seebeck made a number of very accurate observations on the same subject, and in 1835 and 1837 Neumann published an account of further experiments that he had made on the reflection of light by Iceland spar.

He begins his second paper by a brief summary of the results obtained by Brewster and Seebeck. "Brewster found that the angle of complete polarisation for calc-spar depends on the position of the reflecting surface relatively to the axis, and upon the position of its principal section to the plane of reflection; he also found that when the reflecting surface is covered with a liquid the plane of polarisation of the completely polarised ray does not coincide with the plane of reflection, but makes a smaller or greater angle with this; when a cleavage-face of calc-spar is covered with oil of cassia this deviation may amount to 90°. The knowledge of these phenomena has only been further advanced in recent times. Dr. Seebeck has so followed out, by means of most accurate determinations, the influence of optically uniaxial crystals upon complete polarisation that the angle of incidence at which this occurs can be determined as accurately beforehand as it can by Brewster's law in the case of uncrystallised bodies. Seebeck also discovered that the deviation of the plane of polarisation from the plane of reflection, which Brewster had observed, also occurs when the ray of light falls directly from air on to the surface of the crystal."

Seebeck's observations having been mainly directed to the determination of the angle of polarisation, Neumann's object was to determine the azimuth of the plane of polarisation of the reflected light.

Seebeck and Neumann only repeated a portion of Brewster's experiments, and no one except Sir David Brewster appears to have made any determinations of the angles and azimuths of polarisation when the spar was in contact with media other than air.

Prof. Stokes very kindly called my attention to these experiments of Sir David Brewster, and pointed out that, as they had never been published in detail, and had not been repeated by any one else, it was desirable that further observations should be made on this subject. The experiments, the results of which I have the honour of submitting to the Royal Society, were undertaken at Prof. Stokes's suggestion, and in carrying them out I had the benefit of his advice.

The apparatus used was essentially the same as that employed by Seebeck; the divided circle of the goniometer was, however, horizontal, and not vertical, as in Seebeck's instrument, and the arrangement for keeping the reflected ray constantly in the axis of the observing-tube, whilst the angle of incidence was varied, differed from that employed by him.

The measurements were made by altering the angle of incidence and the azimuth of the observing Nicol until the light reflected by the Iceland spar was reduced to a minimum, the position of the crystal remaining fixed.

In order to obtain anything like accurate results with observations of this kind it is necessary to make a large number of determinations and take their mean: it was obvious that there were two ways in which any given number of observations might be grouped, either by making a good many separate determinations for a few positions of the crystal, or by making a few observations at a number of different azimuths; the latter alternative being the one adopted, two readings were made at seventy-two different azimuths of the crystal.

Two complete series of observations were made with cleavage-faces of Iceland spar in air, water, and tetrachloride of carbon, the water and tetrachloride of carbon being contained by a nearly cylindrical thin glass vessel (a chemical beaker), which stood on the horizontal stage of the goniometer, the tetrachloride being prevented from evaporating by a layer of water floating on its surface.

The position of the crystal in which the principal section was in the plane of incidence and the obtuse summit nearest the observer was considered the zero position; when the principal section was in the plane of incidence, and the obtuse summit towards the side from which the light was incident upon it, was therefore azimuth 180°. The crystal was rotated clockwise, and the same direction of rotation was considered the positive direction for the Nicol.

It had been intended to make similar measurements with artificial surfaces cut perpendicular and parallel to the axis of the crystal, and three pieces of Iceland spar cut respectively parallel to a natural face, and perpendicular and parallel to the axis, and all polished with "whiting" were obtained.

Seebeck states (*Pogg. Ann.*, vol. xxi. 290) that Iceland spar polished with rouge or putty powder differs in its optical properties from the natural substance, but that an artificial surface polished with chalk behaves very nearly, if not exactly, like a natural one.

Seebeck's measurements were all made with the crystal in air, and as the changes in the azimuth of the plane of polarisation, and in the value of the polarising angle, for different azimuths of the crystal, when such is the case, are small, it seemed desirable, before making any measurements with the artificial surfaces cut perpendicular and parallel to the axis, to make some determinations with an artificial surface parallel to a natural face of the crystal when the crystal was immersed in water; this was accordingly done.

These results differed considerably from those obtained previously with a natural face in water, and it therefore did not appear worth while to make any further experiments with artificial surfaces, as it seemed certain that the results would be untrustworthy.

The difference between the results obtained with this artificial surface and with a natural surface of the crystal is too great to be explained by supposing that the artificial surface was not cut absolutely parallel to the direction of the cleavage, and must therefore be attributed to some change produced by the polishing, possibly due to the pressure employed (conf. Seebeck, *Pogg. Ann.* vol. xx., 1830, 27).

Prof. Stokes pointed out to me that the experimental results which had been obtained were well suited for reduction by means of the harmonic analysis, and not only explained the method but himself reduced the first set of observations made with a cleavage-face in water. All the observations were accordingly reduced by this method.

Owing to the fact that the principal section of the crystal is a plane of symmetry, the periodic series for the development of the azimuths of the planes of polarisation can contain sines only, and that for the polarising angles cosines only, including the constant term; therefore the coefficients of the cosines in the former case, and of the sines in the latter, were not calculated, except with the observations made with the artificial surface; it seemed possible that the process of polishing might occasion some want of symmetry, and that therefore it was desirable to calculate the values of the coefficients in both sines and cosines.

Omitting the terms which we know from theoretical reasons ought not to appear, and which at any rate are extremely small, we obtain as the final result the following approximate expressions—

Azimuths of the Plane of Polarisation of Light Polarised by Reflection

Cleavage surface in air	$-\ 2^\circ\,10'\sin\theta + 1^\circ\,49'\sin 2\theta + 0^\circ\,2'\sin 3\theta + 0^\circ\,1'\sin 4\theta.$
Ditto, in water	$-\ 9^\circ\,27'\sin\theta + 5^\circ\,29'\sin 2\theta + 0^\circ\,47'\sin 3\theta - 0^\circ\,10'\sin 4\theta.$
Ditto, in tetrachloride of carbon	$-23^\circ\,47'\sin\theta + 10^\circ\,25'\sin 2\theta + 4^\circ\,17'\sin 3\theta - 0^\circ\,24'\sin 4\theta.$
Artificial surface in water	$-\ 3^\circ\,52'\sin\theta + 5^\circ\,11'\sin 2\theta + 0^\circ\,33'\sin 3\theta - 0^\circ\,21'\sin 4\theta.$

Polarising Angles

Cleavage surface in air	$58^\circ\,17' - 1^\circ\,15'\cos 2\theta + 0^\circ\,2'\cos 4\theta.$
Ditto, in water	$52^\circ\,2' - 3^\circ\,14'\cos 2\theta + 0^\circ\,13'\cos 4\theta.$
Ditto, in tetrachloride of carbon	$53^\circ\,9' - 8^\circ\,54'\cos 2\theta + 1^\circ\,12'\cos 4\theta.$
Artificial surface in water	$48^\circ\,53' - 2^\circ\,9'\cos 2\theta + 0^\circ\,1'\cos 4\theta.$

From these expressions the values of the ordinates of the curves representing the phenomena were calculated, and the curves plotted from the values so obtained.

These curves correspond very closely with the smooth curves drawn from the points given by the observations, the values of the ordinates for those portions of the curve corresponding to azimuths 0°–40° and 320°–360°, being rather greater than the values given by the smooth eye-drawn curve. The curves for the artificial surface in water show clearly, when compared with the corresponding curves for the natural surface, how greatly these two surfaces differed in their optical behaviour.

Brewster, in his paper in the *Philosophical Transactions* for 1819, says:—"In any given surface when A and A'' are the maximum and minimum polarising angles, viz. in the azimuths of 0° and 90°, the polarising angle A' at any intermediate azimuth α may be found by the formula $A' = A + \sin^2\alpha(A'' - A)$."

This expression is the same as that given by the harmonic reduction of the observations set forth in this paper, if we assume that the smaller terms are due to errors of observation, as in that case the expression for the polarising angle in air (B) becomes $58^\circ\,17' - 1^\circ\,15'\cos 2\theta$.

Brewster's formula also appears to hold good for the case of Iceland spar in water, as the harmonic series for the value of the polarising angle (D) may be taken as $52^\circ\,02' - 3^\circ\,14'\cos 2\theta$. But with the spar in tetrachloride of carbon the agreement no longer holds, as the coefficient of $\cos 4\theta$ becomes too large to be neglected, being $1^\circ\,12'$. The determinations made in this strongly refracting liquid were less satisfactory than the others, but there is hardly sufficient ground for assuming that the value of the coefficient of $\cos 4\theta$ is merely due to errors of observation.

The experiments, of which an account had been given, confirm the accuracy of Brewster's observations made with a surface of Iceland spar in contact with media other than air, and show moreover that, as Seebeck pointed out, the change in the value of the azimuth of the plane of polarisation of the reflected light also occurs, though to a far less extent, when the crystal is in air, and further, as the refractive index of the medium increases, the change in both these values is greatly augmented.

The harmonic analysis affords a means of expressing approximately at least both these changes as functions of the azimuth of the principal section of the crystal, and further shows that, when the crystal is in air or water, Brewster's formula for the angle of polarisation expresses the facts of the case.

Linnean Society, February 18.—Dr. St. George Mivart, F.R.S., in the chair.—Prof. H. Macaulay Posnett, N.Z., was elected a Fellow of the Society.—Mr. W. Joshua exhibited over 130 species of Lichens from Jamaica, collected by Mr. J. Hart in the Blue Mountains near Gordon Town, and afterwards determined by Dr. J. Müller (Arg.) of Geneva; many of these were of great interest.—Mr. T. Christy exhibited some flowers preserved by a new chemical process; he also called attention to a hitherto unknown Cinchona bark from South Africa; and besides showed a living plant of *Erythoxylon coca* in fruit.—Mr. H. Goss made remarks on specimens of the Wild Parsnip (*Pastinaca sativa*) gathered by him on the Thames side, Moulsey, Surrey.—Mr. A. D. Michael read a paper on Acari of the genus *Glyciphagus*, discovered in moles'-nests. In *G. platygaster* the male, although slightly differing from the female, as is usual in the genus, still can easily be recognised as of the same species; but in *G. dispar*, while the female closely resembles that of *G. platygaster*, the male, on the contrary, is totally unlike in size, form, markings of body, and arrangement of the legs, &c. *G. dispar* also affords evidence of the retro-anal position of the bursa copulatrix, and its being the posterior median projection characteristic of the females of the genus. Mr. Michael speculates wherefore the above divergence of the male form of *G. dispar*, seeing that its habitat and other conditions are the same as its female, and the closely-allied species.—Mr. John Ball gave a communication on the botany of Western South America. He introduced the subject with reflections on the climatal relations of the western seaboard, which have such a remarkable influence on the development of vegetable life. He then describes his collection of plants from Buena Ventura in Columbia, from Payta in Northern Peru, from Caldera in Northern Chili, and Lota in Chili, from the neighbourhood of the Channels of Western Patagonia, and Straits of Magellan, throughout interspersing reflections and brief summaries of the peculiarities of the floras in each of the districts in question. He infers that the vast region including the warm and moist parts of South and Central America should be regarded as a single botanical province, in which the same generic types are represented by species of which a large proportion are endemic, and confined to comparatively small areas. Along with these we find, in various parts of the same region, a few forms so distinct as to be ranked as separate genera, mostly represented by one, or very few, species, and nearly allied to types of wide distribution. He assumes that, in a broad sense, the most natural divisions of the vegetation of the earth are wide areas of low country, over which, with more or less modification, a limited number of types have extended, with islands of high land, which are the original homes of special types that form the characteristic features of different regions.

Zoological Society, March 2.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Mr. J. G. Millais, F.Z.S., exhibited an adult specimen of the Ivory Gull, shot by himself near Thurso, in December 1885; also a young example of the same species, obtained in Scotland in 1879.—Mr. T. D. A. Cockerell exhibited a living Slug of the genus *Parmacella*, obtained at Tangier, and probably referable to *P. valenciennesi*.—A communication was read from Prof. R. Collett, C.M.Z.S., containing an account of a new Pediculate fish from the sea off Madeira, belonging to the family Ceratiidæ, which the author proposed to call *Linophryne lucifer*.—Mr. P. L. Sclater read a note on the external characters of the head of *Rhinoceros simus* as compared with those of *R. bicornis*.—Mr. F. E. Beddard read a note on the air-sacs of the Cassowary.—A second paper by Mr. Beddard treated of the syrinx and some other points in the anatomy of certain forms of Caprimulgidæ.

Entomological Society, March 3.—Mr. Robert McLachlan, F.R.S., President, in the chair.—Mr. J. M. C. Johnston was elected a Fellow, and Cavaliere Piero Bargagli, of Florence, was elected a Foreign Member.—Mr. Pascoe exhibited a curious larva, probably of a *Papilio*, from Pará; and also a pupa-case of *Anosia plexippus* (*Danais archippus*), from the same locality.—Mr. W. J. Williams exhibited, on behalf of Mr. C. Bartlett, a gigantic hairy and spiny larva, perhaps allied to *Gastropacha*, from Madagascar.—Mr. C. O. Waterhouse exhibited *Rutela rufipennis*, *Doryphora haroldi*, and some other (undescribed) species of *Coleoptera*, from Colombia.—Mr. Billups exhibited a specimen of *Cholus forbesei*, found alive in a horticultural saleroom in London.—Mr. Eland-Shaw referred to the exhibition at the last meeting of *Tettix australis* from New South Wales, and called attention to the fact that the aquatic habits of certain species of the genus *Tettix* in India had been previously recorded.—Dr. Fritz Müller communicated a paper on fig insects from Itajahy, South America; and Prof. Meldola exhibited, on behalf of Dr. Fritz Müller, a number of specimens of the insects described in the paper.—Mr. E. B. Poulton read further notes upon lepidopterous larvæ and pupæ, including an account of the loss of weight in the freshly formed pupa.

Dublin

University Experimental Science Association, January 27.—Prof. Cathcart in the chair.—Prof. Fitzgerald showed his new galvanometer. This instrument was constructed, and exhibited in the Inventions Exhibition last year, by the Cambridge Scientific Instrument Company. Its peculiarities are (1) the arrangement by which the coils can be measured in their place, which is an advantage when practical classes are working, and should measure their instruments; (2) the arrangement by which the circle is read with a microscope by reflection-mirrors attached to the magnet, when the instrument is used either as a sine or tangent galvanometer; (3) an arrangement by which a spot of light reads the tangents of deflection. The first advantage is secured by having the two pairs of short and long coils wound in grooves closed in, outside, by a glass plate through which they can be seen, and the external and internal diameter of each layer of wire measured; the transverse diameter, by seeing through small holes left in the ring that covers the coils outside. The reading is effected by viewing a scale engraved on the inside of a horizontal ring surrounding the needle by reflection in two right-angled prisms attached to the needle which reflect opposite sides of the scale. The corresponding lines in the two maps, which differ by exactly 180°, is the line at right angles to the line of intersection of the reflecting planes of the prism. The exact position of that line can be read by means of a micrometer in the eye-piece of the microscope. The horizontal graduated ring is attached through the vertical axis on which the coils, &c., turn to the base of the instrument, and so the same circle does for reading when the instrument is used as a sine galvanometer. By means of a small mirror attached to the needle at 45° to the line of suspension, a spot of light can be reflected through the glass side of the instrument to a scale, and then a uniform scale represents the tangents of the deflections.—Mr. J. Joly, B.E., gave an account of a method of finding the specific gravity of small heavy bodies. The substance, whose specific gravity is required, which may only be a few milligrammes in weight, is melted into a small dish of paraffin of known specific gravity. The paraffin and substance is then floated in a specific gravity solution, and from the formula

$$S = \frac{W}{\frac{w_1}{s_1} - \frac{w_2}{s_2}}$$

the required specific gravity of the body can be obtained. In the above equation W is the weight of the solid, w_2 that of the paraffin, w_1 the sum of these weights; s_2 is the specific gravity of paraffin, s_1 the specific gravity of paraffin and substance together. This method is extremely useful in dealing with porous bodies, owing to the capability of paraffin, when in a molten state, of entering the pores and expelling air. Mr. Joly gave details of a number of experiments which show excellent results.—The next paper was read by Mr. Gerald Stoney, on the dynamics of bicycling. He described experiments made by him, in conjunction with his father, Dr. G. Johnstone Stoney, F.R.S., by which the energy required to propel a bicycle was obtained. They found that it required, when the velocity was 9 miles per hour, about 5500 foot-pounds per minute, and that it often rose higher than 10,000 foot-pounds per minute, which was the highest the apparatus used was capable of recording. Their results were higher than those of other experimenters on the power a man can exert. This shows that the bicycle or tricycle is probably the most economical way of using human muscles. The experiments were made by attaching an indicator-diagram-apparatus to the lever of the safety-bicycle, known as the "Extraordinary," and also by observing the reduction in speed due to friction, when the bicycle was running free. The experiments also showed that the resistance varied almost as the velocity, and that the pressure on the pedal was not constant, but was at a maximum at the centre of the stroke.

Paris

Academy of Sciences, March 1.—M. Jurien de la Gravière, President, in the chair.—Results of the application of the new method for preventing rabies after the bite of a mad dog, by M. Louis Pasteur. Since October 26, 1885, when his process was first announced to the Academy, 350 patients of all ages and both sexes have been treated with perfect success in every case except one. The eminent biologist considers his prophylactic method established, and expresses a hope that a hospital may now be founded for the regular treatment of patients by this process of inoculation. This suggestion met with general approval, and a Commission was appointed to give it effect, including the names of MM. Vulpian, Marey, P. Bert, Jurien de la Gravière, Bertrand, and De Freycinet.—Direct formulas for calculating the momenta of flexion in continuous girders of constant or variable section, by M. Maurice Lévy.—Note on the comparative results of direct astronomical observation with those obtained by MM. Henry's photographic process, by M. Wolf. Discrepancies are pointed out between the photographs of the Pleiades and the author's observations of that constellation in 1874. He adds: "The chart of the heavens now obtained by photography is different from that drawn from direct observation, and it also differs from that which will be obtained twenty years hence by the photography of the future, whose processes will certainly be different from ours. The human eye, on the contrary, is an organ which is always the same; consequently its observations are always capable of being compared together. . . . Celestial photography must work hand in hand with the observer's eye, which it can never replace."—Reply to M. Lalanne's note of February 22, on the mechanical effects of tornadoes, by M. Faye. M. Lalanne's facts are not questioned, but they are shown to be perfectly in accordance with M. Faye's well-known theory.—Remarks on the various theories of tornadoes, by M. Lecoq de Boisbaudran. While admitting the descending movement as the general law, the author suggests that a secondary movement in the opposite direction may perhaps occasionally be produced, which would serve to explain many phenomena difficult to account for on any one theory. —On the equivalent of the terbenes; explanatory note, by M. Lecoq de Boisbaudran.—On the employment of the azimuthal co-ordinates in geodetic surveys, by M. Hatt.—Communication on the approaching centenary of Arago, by M. Mouchez. It was announced, on behalf of the Committee, that the intended banquet in the Hôtel de Ville has been abandoned, and that it has been decided to erect a more lasting monument to the memory of the illustrious astronomer, to take the form of a colossal statue to be raised by national subscription on the Boulevard bearing his name.—Remarks on the *Year-book* of the Imperial Observatory of Rio de Janeiro, presented to the Academy on behalf of the Emperor of Brazil, by M. Faye.—Position of telescopic stars in the constellation of the Pleiades, by M. G. Rayet. A complete list is given of 143 stars observed with the 14 inch equatorial of the Bordeaux Observatory during the winters of the years 1884-85 and 1885-86.—Observations on Fabry's comet made at the Observatory of Algiers with the 0·50 m. telescope, by M. Ch. Trépied.—Orbit and ephemeris of the same comet, by M. Lebeuf. From the observations taken at Algiers, Hamburg, Nice, and Paris, the elements of the new orbit have been determined as under:—

$$T = 1886 \text{ April } 5{\cdot}9580 \text{ Paris Mean Time}$$

$$\left.\begin{aligned} \omega &= 126^\circ\ 36'\ 6''{\cdot}7 \\ \Omega &= 36\ 22\ 32{\cdot}0 \\ i &= 82\ 36\ 34{\cdot}9 \end{aligned}\right\} \text{Equinox } 1886{\cdot}0.$$

$$\log q = 9{\cdot}807626$$

—On the angle of the line of depression below the horizon at sea, by M. E. Perrin. The observations of depression here published were taken in 1884-85 on board the *Galissonnière* in the Chinese seas by means of a Lorieux reflection circle furnished with Daussy's additional small mirror. The mean value of apparent depression was determined at 5′ 31″·5. The corresponding geometric depression being 5′ 46″·8 for an altitude of 9 metres, about 1/23 was fixed for the coefficient of geodetic refraction at sea.—Calculation of mechanical regulators; the proper course to follow in practice in order to establish a regulating apparatus with indirect action, by M. H. Léauté.—Note on the articulated hyperboloid and the application of its properties to the demonstration of De Sparre's theorem, by M. A. Mannheim.—On Deprez d'Arsonval's aperiodic galvanometer employed as a ballistic galvanometer, by M. Ledeboer.—On the spectrum of erbine, by Prof. W. Crookes. The phosphorescent spectrum of this earth, of which a comparatively pure specimen has recently been obtained by the author, showed four green bands coinciding with none of those of the spectra of yttrium and samarium.—On the crystallisation of the paratartrate of soda and ammonia, by M. J. Joubert.—On the relations existing between the variations of terrestrial magnetism and the protuberances and other phenomena observed on the sun, by M. H. Wild. As far as the question has hitherto been studied the author considers it well-nigh established that the great movements of the solar atmosphere are revealed on the globe by corresponding disturbances of the magnetic needle.—Actinometric observations made at Montpellier during the year 1885, by M. A. Crova.—On the hygroscopic properties of tobacco, by M. Th. Schlœsing, jun. —On the isomeric states of the sesquichloride of chromium, green sesquichloride, by M. A. Recoura.—On some immediate principles of the peel of the bitter orange, by M. Tanret.—On the respiratory centres of the spinal marrow, by M. E. Wertheimer. Numerous experiments made on dogs show that in the spine there exist nervous centres, some determining inspiration, others expiration.—On the character of an anomalous rock in the Aspe Valley, Lower Pyrenees, by MM. E. Jacquot and A. Michel Lévy. This rock, by Charpentier called *compact feldspar*, is interstratified at the base of the Carboniferous formations, its age coinciding with the end of the granulite and beginning of the microgranulite eruptions. Although soft and oily to the touch, like the steatites, its dust scratches glass. Chief constituents: silica, 76·33 per cent.; alumina, 14·30; potassa, 3·33; lime, 0·90.—On the stratigraphic relations existing between the miliolite limestones and the *Micraster tercensis* formation in the department of the Haute-Garonne and the canton of Sainte-Croix (Ariège), by M. J. Roussel. The new acts determined by the author show that in the Pyrenees the relations of the Chalk and Tertiary formations are sometimes o an extremely complicated character. But in his remarks on this paper M. Hébert was unable to accept the view that the *Micraster tercensis* of the Pyrenees, essentially a Cretaceous rock, was contemporary with the Tertiary formations containing *Cerithium ladevezi*, *Ostrea uncifera*, and similar fossils.

STOCKHOLM

Royal Academy of Sciences, February 10.—On Binuclearia, a new genus of Confervacea, by Prof. V. B. Wittrock.—On the biology of some Arctic plants, by Prof. E. Warming.—Contributions to the anatomy of the cotyledons of the monocotyledonous plants, by Miss M. Lewin.—On the amount of the rainfall on bare and wooded ridges in the North of Halland, by Dr. H. Hamberg.—Insects collected in the Cameroon Mountain, by G. Waldau and H. Knutson: I. Coleoptera, Cetoniidæ, described by Prof. Chr. Aurivilius.

BOOKS AND PAMPHLETS RECEIVED

"Across the Jordan," by G. Schumacher (Bentley).—"Marvels of Animal Life," by C. F. Holder (Low).—"Japanese Homes," by E. S. Morse (Low) —"Highlands of Cantabria," by Ross and Cooper (Low).—"The Rain-Band," by J. R. Capron (Stanford).—"Lessons in Elementary Chemistry," new edition, by Sir H. E. Roscoe (Macmillan).—"Rotifera," part 2, by Hudson and Gosse (Longmans).—"Bees and Bee-keeping," part 7, by F. R. Cheshire (Gill).—"The Western Pacific and New Guinea," by H. H. Romilly (Murray).—"British Petrography," part 2, by J. J. H. Teall (Watson, Birmingham).—"Indian Meteorological Memoirs," vol. ii. part 5 (Calcutta).—"Report on the Administration of the Meteorological Department of the Government of India in 1884-85."—"The Monthly Weather Report," Oct. and Nov., 1885.—"Proceedings of the Linnean Society of New South Wales," vol. x. part 3 (Cunninghame, Sydney).—PAMPHLETS:—"La Sensibilité et la Motilité des Végétaux," by E. Morren (Hayez, Bruxelles). —"Une Expérience sur l'Ascension de la Sexe chez les Plantes," by L. Errera.—"Fremdländische Zierfische. mit Abbildungen," by B. Dürigen (P. Matte, Berlin).—"The Fixed Idea of Astronomical Theory," by A. Tischner (Fock, Leipzig).—"Report on the Action of the Sheffield Water on the Lead Communication Pipes," by S. White.

CONTENTS

THURSDAY, MARCH 18, 1886

A TEXT-BOOK OF POLITICAL ECONOMY

A Brief Text-Book of Political Economy. By Francis A. Walker. Pp. iv.-415. (London: Macmillan and Co., 1885.)

PROFESSOR WALKER'S "Text-Book," for the most part an abridgment of the larger work published in 1883, deserves to be received with the highest commendation as supplying a much-felt want in English literature of the subject. An introductory treatment of so complex a study as political economy, written with due insight into the theoretical difficulties of the subject, and at the same time with adequate notice of the practical problems which these involve, can hardly be said to be given in any of the smaller manuals in current use in this country. The praiseworthy work of the late Prof. Fawcett, with its condensation by Mrs. Fawcett, kept on the whole too rigidly to the lines prescribed by Mill's classical treatise, and remained unaffected by many discussions which had shown the need of altering or amending the cardinal doctrines so forcibly stated by Mill. There is hardly any portion of the theory of political economy which has not received attention since the date of Mill's exposition, while the pressure of new practical problems has of itself been sufficient to render necessary some revision of the general theory. Prof. Walker, while retaining on the whole Mill's general conception of the limits and divisions of economical science, has incorporated many results of recent research, and has in addition so keen an eye for practical issues that his exposition, even when remaining within the lines of the older doctrine, gains peculiar freshness and interest.

Of the six parts into which the work is divided, the first contains a brief statement, mainly based on Cairnes, of the character and logical method of Political Economy. Parts II., III., IV., on Production, Exchange, and Distribution, contain an admirable *résumé* of the current doctrine, with certain important modifications. As excellent specimens of the way in which the author's keen appreciation of practical conditions enables him to state economical principles in a novel and forcible manner, I would instance the chapters on labour and productive capacity (Part II., Chapters 2 and 4), that on the reaction of exchange upon production (Part III. Chapter 7), and the treatment of market prices. Opinions must differ in regard to what should be included for purposes of elementary instruction under the three staple heads of production, exchange, and distribution, as also in regard to the most suitable order of treatment. Generally Mr. Walker's choice is wise, and his exposition clear of the more thorny theoretical difficulties. It appears to me, however, that much greater expansion might have been given to the section which follows out division of labour into its concrete form—the specialisation of industries, employments, and localities, and in particular the separation of industrial functions. Without a descriptive basis of some such kind, the student finds far too wide a gap between his hypothetically deduced theory of exchange and distribution and the facts of practical life. More might with advantage have been said on the way in which this social development affects competition, and so some more concrete view of capital obtained than is contained in the chapter on that subject. Justice is barely done to the theoretical notions involved in the determination of normal value, and I think that most useful illustrations of a quite elementary kind are to be had from the treatment of local and temporary variations of price, and of cost of transport or circulation. I am unable to persuade myself that the treatment of seignorage, on which Prof. Walker lays unusual stress, is the best or even a good introduction to the discussion of inconvertible paper money, and generally the sections on money seem to me to leave much to be desired. Possibly the problem of the determination and the variation of general prices is too hard for an introductory treatise, but, if it be omitted, unusual caution is required in laying down abstract propositions regarding demand and supply of money. I do not know how Prof. Walker, usually very careful in his use of terms, will reconcile the statements about "inflation" in §§ 164 and 186. On certain points in the treatment of distribution a remark will later be made.

In Part V. a very interesting and instructive treatment is given of some portions of the theory of Consumption. Prof. Walker seems to me justified in all he says of the importance of this part of the subject. But it has peculiar difficulties, and tends to bring before one rather forcibly the often-recurring doubts as to the economical statics which have preceded it. Perhaps political economy is hardly yet in a position to take the important step of regarding its statics as but a special case of the more general, more important, but less easily formulated dynamical principles.

Part VI.—"Some Applications of Economic Principles"—contains interesting but, on the whole, over-brief treatments of some mixed problems of economics and politics, ranging from usury laws to protection. So far as the book is designed for students beginning the subject, nearly the whole of this part might with advantage have been omitted; it does not seem possible to deal satisfactorily in the compass of a few pages with such involved problems as bi-metallism, progressive taxation, and protection.

The treatment of distribution is the portion of Prof. Walker's work in which he deviates most widely from the current doctrine as laid down in Mill's treatise, in which he tends more towards the view of certain French and German economists. The tendency seems to me to be in the right direction, but not to have been allowed sufficient development, and although I attach high value to this portion of Mr. Walker's work, both in its abridged and its larger form, I cannot think that he has been entirely successful in threading the labyrinth of distribution. It is in the province of distribution that the abstraction by the aid of which the economist proceeds to develop his theorems becomes at once most necessary and most dangerous—most necessary, for there is absolutely no single fixed significance attached to the fundamental terms employed; most dangerous, because the attempt to sever may reduce living reality to a mere economical *caput mortuum*. In the theory of production it is comparatively easy to form the *schema* or general picture of the elements, their relations and movements, which constitute the fact to be analysed; nothing is harder than to form any one self-consistent *schema* of the line within which distribution falls. The common complaint that the fundamental categories of rent, interest, wages, and profits, have in popular usage a meaning not that assigned to them by the economists, only expresses a small part of the difficulty. There is hardly an economical treatment of the subject which altogether evades the consequences of the peculiar difficulty that these terms are indifferently employed to mark the remuneration which, in a hypothetical or actual state of society, falls to distinct industrial functions, and the shares which, in like circumstances, are enjoyed by distinct industrial classes. Hardly anywhere is there sufficient recognition of the important distinction between the proximate and the ultimate conditions through which the distribution of produced wealth comes about. Illustration of these difficulties can be given only from Prof. Walker's excellent and most instructive treatment of profits. Here, following, or at all events coinciding with, some of the best Continental economists, Prof. Walker develops the notion of the *entrepreneur* and his industrial function, and assimilates the remuneration of the *entrepreneur* to rent, from which follow certain important general propositions. Profit, apparently, is regarded as the title of the share falling to the *entrepreneur*. Now, undoubtedly there is a portion of the share falling at any given time to the *entrepreneur* which in its origin and laws is identical with rent, for rent is a quite general consequence of any inequality, howsoever arising, in productive sources at any moment needed for the satisfaction of social wants. But it is impossible to identify this with profit at large, —an identification which Prof. Walker appears to reject in § 255, but which he accepts without qualification in the proposition that there is a class of no-profit *entrepreneurs*. There is doubtless a class of no-profit *entrepreneurs*, but the immediate inference is that the term profit is not equivalent to remuneration of the *entrepreneur*, while it is a further consequence that, in quarters where it has not generally been looked for, there is precisely the same rent-element, in wages *e.g.*, and in payment for the use of capital. What conceals it from us in many cases, and makes it disappear in particular conditions, is the greater perfection of the market for services, which tends to remove the inequalities out of which rent essentially emerges. Prof. Walker's analysis of the *entrepreneur* remuneration seems thus to be far from adequate, though it is on the right track. He has not sufficiently recognised that, if we take *entrepreneurs* as a class, then, by whatsoever name we describe it, their remuneration will be a complex quantity, proximately determined by the conditions under which the exercise of the *entrepreneur* function at any moment meets a social want, ultimately breaking up into a number of distinct remunerations, each having its own natural origin and laws. So with wages. To begin the analysis of wages with the conception of the hired labourer, though it keeps one closer to practice, is only to make a first step, and ought not to conceal from us the essentially complex character of the payment so-called. I believe that fundamentally I am in agreement with Prof. Walker in his view of the ultimate condition determining wages, but I cannot assign such importance to it as he seems to do, and I wish that he had observed his own prudent caution (§ 9) regarding the word property, and not thought it necessary to say (§ 273) that, after deduction of rent, profits, interest, "the whole remaining body of wealth daily or annually created is the property of the labouring class"! This is either one of the many truisms that abound in theoretical economics, or it is a dubious, ambiguous, and incautious rule for practice. It is to be added, however, that Prof. Walker's practical observations about wages in §§ 278–289 are excellent and to the point.

R. ADAMSON

ALGÆ

Till Algernes Systematik. Nya bidrag af J. G. Agardh (Fferde afdelningen). VII. "Florideæ." *Lunds Univ. Årsskrift*, tom. xxi. 4to. (*Proceedings* of the University of Lund, Sweden, 1886.)

FOR more than forty-five years the venerable author —now a septuagenarian—of the work mentioned at the head of this notice, has continued to produce, at brief intervals, a succession of standard works on Algæ. We hope this will not be the last. The present work is a fourth instalment of Dr. Agardh's "Contributions to the Systematic Classification of Algæ." The three preceding parts have been already reviewed in NATURE.[1]

The recent part, which consists of 117 pages, is devoted to the Florideæ. Besides observations elucidating many genera and species already partially known, it contains descriptions of three new genera and between fifty and sixty species. Of the new genera, Titanophora, which belongs to the Nemastomeæ, contains two species—*T. incrustans*, J. Ag. (*Halymenia incrustans*, J. Ag.), and *T. Pikeana* (*Galaxaura Pikeana*, Dickie)—both from Mauritius. The other new genera belong to the Rhodymeniaceæ, namely, Glaphyrymenia, of which there is one species—*G. pustulosa* (see Fig. 4)—and Merrifieldia, which also contains one species—*M. ramentacea.* The last-mentioned alga is one among several instances where the algologist has had to wait many years before he had amassed sufficient material to enable him to give an accurate description of the plant, and to decide on its place in the system. Every one who has collected algæ must know how frequently it happens that plants are dredged or cast ashore in an imperfect state. In some the lower part may be absent; in others the apices of the ultimate branchlets may be broken off; in others, again, the plants may be sterile; or, in the case of the Florideæ, they may bear but one species of fruit. Until, therefore, perfect plants, bearing ripe cystocarps, and others bearing sphærospores, have been thoroughly examined, neither the genus nor the species of the plant can be accurately determined. *M. ramentacea* was first partially described by C. Agardh, in the "Systema," upwards of sixty years ago, under the name of *Chondria ramentacea*, and afterwards by his son, Dr. Agardh, in the "Epicrisis" (p. 661), as *Hypnea ramentacea.* The examination of subsequent examples, with fruit of both kinds, has induced Dr. Agardh to consider this alga as the typical species of a new genus.

[1] The first part, containing a revision of (1) Caulerpa, (2) Zonaria, and (3) certain groups of Sargassum, was published in 1872, in vol. ix. of the *Proceedings* of the University of Lund; the second part, containing (4) Chordarieæ, and (5) Dictyoteæ in vol. xvii.; and the third part, containing (6) Ulvaceæ in vol. xix. of the *Proceedings* of the same University.

In Fig. 5 the cystocarps and sphærospores, in different degrees of development, are represented.

Two other genera at present but little known, namely, Marchesettia (Hauck) and Melanoseris (Zan.), are also commented on. The former is a most singular alga, in appearance much more like a branched sponge than a plant, and, except for the little deep-red fruit-leaflets, it might readily be taken for one. The discovery of the fruit shows that its affinities are with Thamnoclonium. One of the several new species of this genus, described in the present work, so much resembles Marchesettia, that it has been named *T. Marchesettioides*.

The other genus, Melanoseris, is nearly related to Pollexfenia, from which it is distinguished by the fruit in the former being marginal, instead of on the disk, as in the latter, and by its smaller size.

Halymenia saccata (Harv. and H. "Fl. Tasm.") has long been a puzzle to algologists. Dr. Agardh now refers it to Bindera, supporting his opinion by a comparison of the structure and fruit with those of *Bindera splachnoides* (see pp. 41-46, and Fig. 3).

Another plant, *Amansia? Marchantioides*, first mentioned in the "Flora of New Zealand," had not, hitherto, been accurately determined. Dr. Agardh now considers it to be a Placophora.

Among the more interesting of the new species is *Cliftonæa imbricata*, of which one specimen only has yet been discovered. This was also the case with *C. semipennata*, of which one example only is known to exist.

The present work is illustrated by one plate. The eight figures are printed in a red ink, which is somewhat dazzling to the eyes.

In conclusion, we venture to suggest that *Gracilaria Millardetii* (p. 64) should be *G. Maillardetii*, the plant having been named by Montagne *Rhodymenia Maillardetii*, in honour of M. Maillard, the author of "Notes sur l'Ile de Réunion."

OUR BOOK SHELF

Practical Chemistry, with Notes and Questions on Theoretical Chemistry. By William Ripper, Assistant Professor of Mechanical Engineering, Sheffield Technical School. Second Edition. (London: Isbister and Co., 1885.)

TRULY the number of little books coming into existence, presumably to aid students to do the Science and Art Department's examinations, is very great, and they are not by any means always good. The evil of a big book has evidently been well seen by chemical teachers, and more especially by teachers connected with the Department's examinations, many little books springing up intended originally for the class or school to which the teacher is attached only. In some, the greater number of cases perhaps, this is a very happy thing for students in general. When a book of this kind passes through two editions in a reasonably short time there is some cause for its survival. The book before us has evidently fulfilled its mission in a fairly satisfactory manner. It is still decidedly one of the cramming class, but it contains an amount of matter simply and well arranged which, with the aid of a teacher, or demonstrations, should enable any ordinarily industrious student to "pass" the first stage of the "Department's" examinations.

The first part contains descriptions of experiments on the non-metallic elements, reactions for metals and acids, and tables for the examination of a simple salt. The second part, called "Theoretical Chemistry," is mostly equations, and questions and problems.

Free Public Libraries; their Organisation, Uses, and Management. By Thomas Greenwood, F.R.G.S. (London: Simpkin, Marshall, and Co., 1886.)

IF in Her Majesty's dominions there is a spot where newspapers do not penetrate and where free libraries are only known by name, *and yet* where some pioneering spirit only requires a spark to set aflame the desire to start such an institution, this book will be a fitting flint and steel for the purpose. But as such a combination is to be found in very few places, we cannot encourage the writer to hope that many will read his 500 pages of newspaper cuttings with much satisfaction. To any *reader* who is within measurable distance of earnestly considering that "most interesting question of the day—how to work a free library in a small community"—nine-tenths of this book, commencing its survey as it does at the British Museum, will be provokingly irrelevant; he will grudge the time taken up in finding where the practical information is scattered. As a missionary book, crying in the wilderness the advent of knowledge, it is less likely to make its way than the newspapers from which it is compiled, and it is thoroughly wanting in the eloquent earnestness of the prophet.

Still there is much excellent advice to those who know nothing about the matter; and since it seems to have been written, as the compiler says, "with the earnest hope of increasing the number of free libraries" (there are 133 now open in Great Britain) we gladly call to it the attention of any to whom such a book as we describe may be useful. The combination in the writer of librarian and newspaper editor has made easy to him much that would have been a considerable labour to others who might have gone more deeply into the subject, and his information is brought down to marvellously recent date.

The hasty way in which it has been put together is illustrated by an account on p. 83 of "first failures," which apparently apply to Sheffield, and are not discovered to belong to Newcastle-upon-Tyne till three pages further on there comes a full-page engraving of the important building opened there in 1884 by the Prince of Wales. A puzzled reader may guess that a short paragraph on p. 100 should have introduced its history, but that it found its present place among the author's notes through confusion of the name with that of Newcastle-under-Lyme. The same haste appears in more important matters. Mr. Greenwood very properly urges the importance of the librarian as the "vocal key to the catalogues," and gives a touching illustration of the value of knowledge and sympathy in that officer. "Wives and children come for books, and make the request, 'Please pick me a nice one, sir, for if I take home an interesting book, my husband (or father, as the case may be) will stop in during the evening and read it to us.'" We must point out the inconsistency between this and the unqualified advice he gives to the librarian not to stand "at the desk entering out and taking in the books, and so uselessly employed in doing the work of a boy." It will be found that as such a librarian stands at the counter and hears the wants expressed of the class for whose benefit chiefly these libraries are considered to be established, the circulation of books will increase; while if it is left to a boy to do the work, the popularity, the circulation, and to a far greater extent the good work, of a free library will fall off. The same consideration also should qualify the zeal with which the use of indicators is urged, which, though theoretically very simple, and to the library officials very time-saving things, yet practically do not work where any attempt is made to accommodate the class just referred to, or an unlearned public who, it will be found, *won't* use catalogues. For one minute, however, which they save the librarian, they hinder five minutes of the borrower of the more intelligent class; to whom, also, the most recent catalogue (and hence the indicator) is generally deficient of three-fourths of the books he most wants, viz. the new ones.

Nothing is better than the advice given here to secure a good librarian even at a higher cost than some may consider proportionate to the income. But the committee having taken that advice, there is little in this book which will be of value to either him or them. W. ODELL

Les Aérostats dirigeables. Par B. de Grilleau. (Paris: Dentu, 1884.)

THIS little book does not add anything to the scientific data regarding the direction of balloons which we have lately published; indeed it was written before the best and most conclusive trials were made. It is a popular view of the subject only; but it is useful as combating the ignorant prejudice existing thereon in the public mind. It points out to whom the successful solution of the problem is due; it states the results that have been obtained, and it shows what may be expected to be done in the future. It also explains clearly some of the conditions affecting the question, which are often misunderstood, such as the effect of the wind, the effective speed obtainable, the nature of the propelling action, and so on.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Clifford's "Mathematical Fragments"

A SHORT time since I lent the originals of this work to Mr. A. B. Kempe, F.R.S., as he has been working on the subject of "graphs." Some remarks he made on returning the "Fragments" led me to compare them with the lithographed work, and I propose to supply what is, I think, a defect in the published book.

The "Mathematical Fragments" are reproduced on xxii. pages of a *uniform* size which in the original manuscript is that of the first 5 pages only. The paper of these pages is blue, and has ruled lines. Page vi. corresponds to *two* pages of manuscript, indicated by a break, two other pages being blank. Page vii. corresponds to two *distinct* pages of manuscript. Page viii. is made up of three parts, the first six lines on one page of manuscript, the next thirteen of another page of manuscript. These last pages of plain white paper are approximately $4\frac{1}{2}$ inches wide by $5\frac{1}{2}$ inches deep. The page is filled up with a fragment on plain blue paper approximately $5\frac{1}{4}$ by 8 inches. Page ix. is on stout plain white paper, app. 7 inches by 9 inches. The last five lines of book are written on the back of the paper. Pages x.-xvi., xviii.-xxi. are written on thin white paper of the same material as page vi., size 9 inches by 11 inches; the pages are all *detached;* page 15 is on back of page 14, and page 19 on back of page 18. Page xx. is made up of two distinct pages of manuscript, the second commencing at the defaced word which is clearly in the manuscript "Degree." Page xvii. is written in pencil on stiff white paper, folded in half, the lower fragment in the manuscript being in the lower half of the page, and at right angles to the upper—size of full page, app. 7 inches by 10 inches. Page xxii. is made up of three pages of manuscript: the uppermost fragment is on white paper, 6 inches by 4 inches; the immediately following four lines of writing are given on the back of this page. The next three lines are on paper 7 inches by 10 inches, and the last four lines on precisely similar paper. The time notes at the side have, of course, nothing to do with "graphs."

These "Fragments" have been circulated (see "Papers," p. 286) chiefly amongst libraries; if the details I here supply are indicated in the copies, their value will, I believe, be greatly increased, and much trouble may be saved by students when they know how slender a connection there is in some cases between consecutive pages of the text. In the manuscript there is no indication of the order in which the pages should be read beyond what I have pointed out above. The manuscripts are now deposited in the Library of University College, Gower Street. R. TUCKER

The Upper Wind Currents in the South Indian Ocean and over the N.W. Monsoon

AFTER sending a brief account to NATURE of my observations on the upper wind currents over the Atlantic doldrums, I started from Natal for some journeys across various portions of the Indian Ocean, to investigate the circulation of the higher atmosphere in that region.

I first went to Mauritius. During the whole passage from Natal, at the end of December, we sailed in the S.E. Trade, with an almost constant movement of high cirrus from the N.W.

Though I was disappointed in not meeting with a cyclone in those seas, still I succeeded in obtaining much valuable information about the details of hurricane weather, which could only be learnt on the spot. One point relating to upper currents is very important. The cirrus which appears five or six days before the arrival of a hurricane follows the normal course from N.W. or S.W., and is no guide to the path of the cyclone. But on the outskirts of the hurricane, low clouds afford valuable information. If the cloud over the S.E. surface-wind inclines towards E. the centre of the cyclone will pass to the N.; if on the contrary the low cloud inclines towards S. the centre will pass to the S. of the observer.

Though Meldrum, and Bridet of Réunion, both agree on this point, the subject requires further elucidation, for such a rotation of upper currents is contrary to all analogy of what is supposed to hold round cyclones in the northern temperate regions. I am certain from my own investigations that the general character of tropical and extra-tropical cyclones is identical. In Mauritius hurricanes I find the same oval form, the same squall at the turn of the barometer, the same halo in front, and hard, detached cloud in rear, which characterise European cyclones. Mr. Harris has recently traced a cyclone from its easterly course as a typhoon in the China Seas, across the Pacific, United States, and Atlantic into Western Europe. Like every other long-lived cyclone, this one received accessions of strength by fusion or coalescence with others which had formed outside the tropics. It is perfectly certain that cyclones which revolved on different systems could not unite, and I think that the motion of the lower layers of cloud over the northern side of our own cyclones should receive special attention. At present we are led to believe that the cirrus in front of a cyclone, both right and left of the path, comes from S.W. or S.

Be this as it may, cloud motion forms a useful adjunct to a valuable and successful system of hurricane forecasting that is carried out by Mr. Meldrum, who, in the absence of telegraphs, has to rely entirely on his own instruments and above all on his own experience and judgment. Another interesting feature of this system is the care which must be taken to allow for the diurnal motion of the barometer during the slow diminution of pressure which always precedes the arrival of a hurricane.

From Mauritius I sailed to Adelaide, so as to examine the Polar limit of the S.E. Trade. Though we steered a great circle course which took us fully into 39° S. latitude, we experienced constant S.E. and E. winds. These must have been due to some extra-tropical anticyclone, and every observation of low or middle layers of cloud showed a current practically in the same direction as the surface-wind.

At Adelaide I learnt that the normal direction of the highest currents is from N.W. In that city the direction of the surface-wind is much influenced by land and sea breezes. Through the kindness of the acting chief of the Observatory, Mr. W. E. Cooke, I was able to confirm what I had previously suspected from my investigations in Melbourne last year, that sometimes at least the characteristic "southerly bursters" of Australia, are due to that class of V-shaped depression in which the rain occurs in rear of the disturbance. Other times the sudden irruption of S. wind appears due to the shift of wind at the passage of the trough of a cyclone.

From Adelaide I came here to Colombo so as to repeat a section of Indian Ocean very nearly at the same season and in the same straight line as last year. The results of the former voyage were communicated to NATURE, vol. xxxii. p. 624, when I announced the fact that the highest currents over the

N.W. monsoon came from points of E., and not from W., as might have been anticipated.

In this journey I found the clouds at the Polar side of the S.E. Trade coming constantly from a point either side of the surface-wind, that is, from S.S.E. to E.S.E. When well in the Trade, the middle clouds always came from some point more east than the surface-wind, or in accordance with the usual circulation of the southern hemisphere. No high cirrus was ever observed.

We found no doldrum, but ran straight from the Trade, under a bank of cloud, into the N.W. monsoon, in about 12° S. latitude. In that monsoon the low and middle clouds always came a little more from the N. than the surface N.W. wind, or in the manner of the upper winds of the northern hemisphere. All the high cirri moved from E. or N.E., except on one occasion, when they came from S.

The N.E. monsoon which we picked up on the equator was so clear that I only obtained one observation of cirrus which came from N.E. when the surface-wind was N.N.E. The lower layers of cloud usually drove from the same direction as the surface-wind, though on one or two occasions they came from a point more N. than the surface.

The above results entirely confirm the observations described in my previous letter of a deep S.E. Trade and of an easterly current over the N.W. monsoon. RALPH ABERCROMBY

Colombo, February 15

Glacier Bay in Alaska

I THANK your correspondent, Mr. Chauncey Thomas, for pointing out my error in describing Glacier Bay as opening into Chilcoot Inlet, and for more exactly indicating its position. When I visited this region I was provided only with a small and inaccurate pocket-map, in which I found it difficult even to trace the course of the steamer, and I was under the impression that the whole of the fiord northward from Chatham Strait was known as Chilcoot Inlet, though my statement would still not be quite correct.

It may be well to add that my object in arranging my rough field-notes for publication was not to describe the glacier as a whole, but to draw attention to some uncompleted observations of special geological interest which it seemed to me ought to be made known as indications for future explorers; and it should be borne in mind that my estimates of heights and distances were only estimates based on opinion, and not on any system of actual measurement. The very limited time at my disposal, and my desire to get over as much ground as possible in that time, precluded the use of more satisfactory methods.

Bridlington Quay, March 13 G. W. LAMPLUGH

A Correction, and the Distribution of Appendicularia

(1) THE specimen which I referred to in NATURE (Jan. 7, p. 221) as being probably a new species of *Chætoderma*, has turned out on a more detailed examination not to be Chætoderma at all. Therefore I must withdraw the statement that that genus has been found in British seas.

(2) Can any of your readers who have been using the tow-net round our coasts give me information in regard to the occurrence of the Appendiculariidæ? Forbes and McAndrew found *Appendicularia* off the north coast of Scotland in 1845. Allman found it in the Firth of Forth in 1858, and Sanders at Torquay, 1873; and it has been taken by Huxley on the English coast. It was seen in quantity by Sorby off the south coast of England a couple of summers ago, and I obtained it in Lamlash Bay in 1880 and 1884, in Loch Fyne in 1883, and off the Mann coast in 1885. Apparently it is much commoner and more generally distributed than is usually supposed. I would be glad to hear of any additional records of the occurrence of the Appendiculariidæ in our seas. W. A. HERDMAN

University College, Liverpool

Morley's "Organic Chemistry"—Correction

IN my notice of Dr. Morley's "Organic Chemistry" in this week's NATURE, the reference to "Ladenburg's synthetic optically-inactive coniine (α-isopropylpiperidine)" (p. 436) contains an inaccuracy. Instead of "coniine" it should read "coniine-base." F. R. JAPP

Normal School of Science, March 11

"Peculiar Ice-Forms"

IN NATURE, vol. xxxi. p. 5, you allowed me to describe, under this heading, a curious and beautiful form of fibrous ice met with near Chamonix, which I, and other of your correspondents who discussed the matter, thought to be very unusual, though later communications seemed to show that it is commoner than we had supposed.

It may be interesting to note that a day or two ago I came upon the same form of ice in considerable quantity in a very unexpected locality, viz. on the path leading from Gerozano to Lake Nemi, in the Alban Hills. Attention was drawn to the circumstance by the crackling of the ice under foot, otherwise there was no visible indication of its presence except that, where it existed, the path was slightly damp (which was not the case on other parts of it), the dampness being evidently due to the partial melting of the upper stratum of the ice, which was everywhere covered with a layer of earth. The ice was almost exactly similar to that found at Chamonix, but only an inch and a half to two inches deep, and in three layers, easily detached from one another, and evidently the result of successive frosts.

We afterwards found that a bank beside the road between Albano and Frascati was covered with the same formation for several hundred yards; but it would certainly have escaped detection, being everywhere covered with earth, if our previous discovery had not led us to recognise it. This proves that it may often exist unnoticed.

The conditions were precisely similar to those under which this particular form of ice has been observed before—viz. a northerly aspect—a very porous soil (in this case volcanic), bright, sunny days, and clear nights with a low temperature.

Rome, March 12 B. WOODD SMITH

REMARKABLE DISCOVERY OF RARE METALS IN DILUVIAL CLAYS [1]

DR. STROHECKER, of Frankfort, has carefully examined and analysed the clay which is found in the neighbourhood of Hainstadt, near Seeligenstadt, and he has made the remarkable discovery that this clay, which has been largely used for building purposes, contains considerable quantities of some of the rare metals, and more especially cerium. The beds are extensive, and consist of layers differing considerably in appearance and composition.

The composition of picked samples of the two upper layers is as follows:—

	No. 1	No. 2a
SiO_2	47·5444 ...	58·3331
TiO_2	trace ...	—
Al_2O_3	24·5937 ...	11·7607
BeO	6·4399 ...	5·3833
Fe_2O_3	0·9190 ...	0·6356
$Ce_2(OH)_6$	13·4214 ...	9·4012
DiO	— ...	0·8474
LaO	0·8576 ...	2·6536
YO	— ...	1·6949
MgO	1·5901 ...	1·8659
$CaCO_3$	0·8878 ...	—
$CaSO_4$	0·1361 ...	0·2015
CaO	— ...	0·5883
P_2O_5	trace ...	2·0691
K_2O	2·3236 ...	0·5648
Na_2O	1·2137 ...	0·5838
NH_4Cl	— ...	0·0529
Loss on ignition ...	— ...	4·1057
	99·9273	100·7418

The cerium and yttrium oxides appear to be derived from orthite, which is known to occur in the syenite at Weinheim. The upper layer (No. 1) of the clay varies in colour from a bright flesh-colour to a dark cinnamon-brown, indicating that the cerium hydroxide, which is the colouring substance, varies in amount at different points. The bricks made from this clay vary in colour according to the temperature at which they are burnt, the lightly-burnt bricks having an orange-yellow colour, whilst those

[1] *Journal f. prakt. Chemie*, 1886, pp. 132 and 260.

burnt at a white heat are leather-coloured, and have a silver-gray appearance.

The second layer (No. 2) is divided into two varieties, *a* and *b*, the former of which is black from the presence of lignite, and yields lemon-yellow bricks; this colour is due to the conversion of the cerium oxide Ce_2O_3 into the lower oxide Ce_3O_4 by the action of the carbon which is present. The *b* variety is blackish-gray, and yields orange-red to orange-yellow bricks.

The third layer contains less cerium than the other two, and the bricks made from it are of a fainter orange colour.

The amount of glucina present is very characteristic of the Hainstadt clay. Ammonium chloride, which occurs only in traces in some portions of the clay, exists in quantity in others; and in one piece which crumbled to pieces a crystal of sal-ammonia was found measuring about 2 centimetres in length and 1·5 centimetres in thickness.

It will be seen from the above that the oxides of cerium which were hitherto of only theoretical interest, are now of technical importance. They have long served as colouring substances in building materials without the fact having been known, and from the large amount present in the Hainstadt clay there are prospects of their being brought into use as paints.

The variation in the colour of the bricks, already mentioned as being produced according to the degree of heat to which they are submitted in the process of burning, does not appear to be due to any action of the silicate on the ceric oxide, as the latter substance can itself be made to assume either colour by igniting it at a suitable temperature. The small amount of iron present in the clay is found to have no influence on the colour of the bricks, which however is affected by the admixture of larger quantities of iron. Dr. Strohecker mentions a number of streets in Frankfort in which houses constructed of the different sorts of cerium bricks are to be seen; the leather-coloured bricks occur in Palmstrasse, Bergerstrasse, Schleidenstrasse, Schillerplatz, Goetheplatz, &c.; the orange-red bricks at the police-station, the law-courts, and in the walls of the zoological garden, &c., and the lemon-yellow bricks at a villa near the west station at Hanau, and at a house in the Verlängerte Zeil at Frankfort. The houses of the peasants near Hainstadt are built of lightly-burnt bright flesh-coloured and yellow bricks.

The somewhat remarkable fact that chemists have so long failed to recognise anything other than ferric oxide as the cause of the colours in these bricks may probably be explained by the large number of shades of colour produced by iron in its various stages of oxidation, by the presence of manganese, and by the employment of mixed clays containing the oxides of both cerium and iron.

HARVARD COLLEGE MUSEUM REPORT

PROF. AGASSIZ' Report, dated October 1885, has just reached us, and, as usual, it presents several topics of interest. Since the first section of the Museum was inaugurated in November 1860, the establishment has passed through many changes, and from being, at its origin, a State institution, it has gradually assumed that of an independent department of the Harvard College. While it has thus lost the immediate support of the State, it has gained the good will and interest of the students of the College, the class upon whom it must in a very great measure depend not only for its maintenance, but for its being a source of intellectual and scientific good.

During the first decade of its existence the resources of the Museum were spent in forming collections which, in some branches of science, have made it a great scientific centre. During this period of ingathering the teaching powers of the place were interfered with. Now this period has so far passed that the resources of the place will be chiefly expended on its teaching, its original investigations, and its publications.

The foundation of this Museum dates from the publication of the "Origin of Species." The powerful movement effected by this work on the scientific thought of the age has not failed in modifying the problems which this institution was intended by its original founder to illustrate and to solve; and rightly does the son write that, if the synoptic, systematic, faunal, or palæontological collections should cease to bear the interpretation given to them by his father (the founder), their interest and importance for the advocates of the new biology would not be one whit lessened.

It is pleasant to note that the plans of Prof. Louis Agassiz—the founder of the Museum—have been, it is known, realised, and indeed beyond his most sanguine expectations, and that his son and successor now sees the establishment of a prosperous School of Natural History, amply provided with laboratories, connected with a University, and recognising in the administration of its trusts the claims of the College and of the advanced students, as well as those of the original investigator, and giving to both the latter ample opportunity of publishing their theses or researches. It has not even forgotten the specialists, for whom it has collected vast stores—stores in every way available, as most of the specialists in Europe will gladly testify.

Very truly writes Prof. A. Agassiz in reference to original investigation, that such is always best promoted in connection with educational institutions, and we would that the fact were more recognised in these countries; and in regard to museums belonging to such he suggests that they should grow so fast, and no faster, as the demand for such growth arises, otherwise they become mere unwieldy and meaningless accumulations. We may add that in countries where large museums are kept up by the State, University or College Museums on an extensive scale are a vast mistake. The college student's needs are very limited, and the money spent on adding to and keeping up collections would be infinitely better expended as aid to original research. All experienced teachers know how small is the stock of material required for their demonstrations, and how comparatively easy nowadays it is to procure such.

Prof. Agassiz hints that it would be desirable if, in connection with the Laboratory of the United States Fish Commission, the Universities of the United States should found a sea-side laboratory, which would render unnecessary, unless for special work, the various establishments already being established along the American coast. The hint should not be lost on our own Universities and Colleges, which should be urged to assist in the establishment of the British Biological Station. A long list of donations and purchases, an account of the work done, memoirs published or assisted by the loan of collections, conclude this very interesting Report.

TECHNICAL EDUCATION IN NEW SOUTH WALES

THE progress of technical education during the last few years in this country has been watched with great interest by some of our more important colonies which are desirous of not lagging too far behind the mother country in their arrangements for giving special instruction to artisans in subjects allied to the industries in which they are engaged. The Report of the Minister of Public Instruction of New South Wales recently issued contains some interesting particulars as to the establishment of a Technical College in Sydney and the organisation of trade classes in the colony. The present

Technical College of Sydney, like many similar institutions in this country, has grown up out of the Sydney School of Arts. From 1873 to 1877 plans for the extension of the school were carefully considered, and in 1878 the Colonial Parliament granted 2000*l*. towards the inauguration of a Technical College. In 1883 the Government decided to establish a State system of technical education in New South Wales, and having carefully examined the scheme of the City and Guilds of London Institute, and compared it with what was being done on the continent of Europe, they decided that the course of study and system of instruction to be adopted in their college should "accord with the practice of the City and Guilds of London Institute, with such modifications as seemed necessary to meet local requirements and appliances." "Following out the principle laid down by the City of London Guilds for their own guidance, the Board of Technical Education resolved that the object of technical instruction in the colony would be to improve the industrial knowledge of workmen by teaching the sciences and principles underlying their handicraft, and that such teaching should be illustrated by the best apparatus and machines that can be obtained, and by visits to workshops, manufactories, &c." No sounder views than these could be expressed. In 1884 the Parliamentary vote for technical education had increased to 17,093*l*. 3*s*. 4*d*., and more than forty classes were in operation at the College. These figures indicate the great advance that has been made. As now organised, the College contains thirteen departments, viz., Agriculture, Applied Mechanics, Art, Architecture, Geology, Chemistry, Commercial Economy, Mathematics, Music, Elocution, Pharmacy, Physics, and Domestic Economy. Some of these subjects are outside the curriculum of our own Technical Colleges; but there is much to be said in favour of the introduction of some non-scientific subjects into a technical course; and where statesmanship is almost a profession the study of elocution in early youth is of distinct advantage. The average number of students in the College during the past session has been 917, and the fees paid by the students amounted to 1838*l*.

For the benefit of artisans engaged in the building-trades, classes have been established in decoration, plumbing, bricklaying, wood-carving, carpentry, and joinery; and in many of those classes the syllabus of instruction is identical with that in use at the Finsbury Technical College. Recently, the Council of the City Guilds Institute have received an application to extend their technological examinations to the colony, and to award certificates and prizes on the results. This application is at present under the consideration of a Committee of the Institute. There can be no doubt that all efforts to bring the colonies and mother country into closer relationship should be encouraged, and the more the colonial system of education is assimilated to our own, the greater will be the sympathy between the colonists and the inhabitants of the United Kingdom. This sympathy is of greater advantage to our commercial interests than is generally supposed; for it tends to link together the colonies and the mother country into one vast empire, the several parts of which will depend upon one another rather than upon foreign markets for the supply of their various wants.

It is to be hoped that the example of New South Wales will be followed by Victoria, and may extend to New Zealand and to other parts of our colonial empire. The advancement of technical education in our colonies is to us a matter only second in importance to the improvement of the means of technical instruction in our own manufacturing towns; and it must be a source of satisfaction to the City and Guilds of London Institute that the influence of its operations is being felt, not only in the centres of our home industries, but already in one of the most flourishing of our colonies.

SEEBOHM'S HISTORY OF BRITISH BIRDS[1]

SINCE our last notice of Mr. Seebohm's book (NATURE, vol. xxviii. p. 126) the author has brought it to a successful conclusion, and has fully sustained his reputation as an original and painstaking writer. The great defect in our standard works on British birds has been a want of originality, as one author after another, and one editor after another, have compiled books on the subject, each one founded on the labours of their predecessors, so that the best books have been but compilations. Mr. Seebohm has started on quite a different principle, and the greatest charm of his book consists in the account of the life and habits of the birds, drawn from his own actual experience of the species in their native haunts. And before giving to the world his varied experiences, he has, as is well known, travelled extensively in Europe and Northern Asia, and has become celebrated as the discoverer of the breeding-places of many species of European birds, previously unknown. In this respect he resembles the late John Wolley, for whom a fellow-feeling of sympathy is expressed by Mr. Seebohm throughout his work, but, more fortunate than that well-known naturalist, our author has survived to record in his own books the results of his successful expeditions. It must not, however, be supposed that Mr. Seebohm, in giving us detailed accounts of the life of the birds, has neglected in any way the scientific portion of his task. On the contrary, he has grappled with this difficult subject in a manner which is highly creditable, and however divided opinions may be as to the advisability of some of the changes of nomenclature which he introduces, there can be no question as to the greater simplicity which he has once more attached to the names of the British birds, and we believe that he will be largely followed. Some revision of the code of rules proposed by the British Association appears to us to be necessary, and we trust that ere long Mr. Seebohm or some other ornithologist will draw out a scheme for their modification, in order to bring them into harmony with the more advanced state of science of the present day; and an attempt to arrive at a definite understanding with our Continental and American brethren as to the employment of a uniform system of nomenclature ought soon to be made. The opportunity may probably come when the authoritative "List of North American Birds" is promulgated by the American Ornithologists' Union, a work which is anxiously awaited by naturalists in this country, and it will then be competent for us to consider the merits and demerits of the trinomial system of nomenclature which is gaining ground considerably on this side of the water, but which cannot be adopted without the utmost consideration. Mr. Seebohm does not hesitate to adopt it, but how far he will be followed remains to be seen.

We can cordially recommend this book to all lovers of ornithology, both at home and abroad, and to young and old alike, for they will find ample material for study, and a very great deal that is new. It is by far the best introduction to a knowledge of British birds that we are acquainted with, and a great deal of the subject-matter is very original. The criticisms of contemporary ornithologists are occasionally somewhat hard, but no one can complain of a want of candour on the author's part, and as he no doubt expects equally hard hitting in return, he must have counted the cost before striking at the authors who so often arouse his ire. One thing we do not clearly understand, and that is the constant odium thrown by Mr. Seebohm upon the "Ibis List of British Birds" compiled by a Committee of the B.O.U., of which the author was himself a member. A long time was spent by this Committee in investigating the subject, and as its conclusions were carried by a majority of votes, all the members

[1] "A History of British Birds; with Coloured Illustrations of their Eggs." By Henry Seebohm. Vols. I. to VI. (London: R. H. Porter, 1883 to 1885.)

of the Committee ought to acquiesce in its decisions. We ourselves do not agree with every point of the Committee's work, but at the same time the "List" supplied a great want in ornithology in this country, and it will, no doubt, be greatly improved in a second edition.

Oologists in this country have in Mr. Seebohm's work a thoroughly good hand-book, the figures of the eggs being highly satisfactory, while as to the information concerning the nesting-habits and life of the birds, we believe this "History of British Birds" to be by far the most complete yet published in this country. R. B. S.

NOTES

THE collection of funds for the Pasteur Hospital is proceeding rapidly. The total of the first list is a little under 10,000*l.*

IN reply to a recent letter from the Russian Minister of Education, M. Pasteur has written offering to receive Russian doctors for instruction, and suggesting that Russia should contribute towards the establishment of his proposed Institution at Paris. A small establishment for the application of M. Pasteur's method against rabies has already been started in St. Petersburg, on the initiative and at the expense of Prince Alexander of Oldenburg, where experiments on rabbits and dogs are now being made, preparatory to the treating of persons in danger of hydrophobia.

IN the House of Commons, last week, in reply to a question by Sir Henry Roscoe, Mr. Chamberlain stated that his attenhad been called to the reported discovery by M. Pasteur of a cure for hydrophobia. The recognised eminence of M. Pasteur as a scientific investigator, and the great interest and importance which attach to the subject of his recent inquiries, seemed to him to justify a careful and impartial examination of the results obobtained. At present the information on the matter in the possession of his department was too vague and incomplete to afford materials for a full appreciation of M. Pasteur's process. Mr. Chamberlain promised to consider how such an inquiry can be most satisfactorily conducted, and to confer with the Chancellor of the Exchequer with reference to the question of the expense. He hoped to be able to arrange for such an investigation as may enable a just estimate to be formed as to the reliability of M. Pasteur's method and its applicability to this country.

THE French Minister of Public Instruction has applied to the French Parliament for a grant of about 150,000 fr. for the building of an equatorial-coudé according to the Lœwy system. The total sum required will be 100,000 fr. more.

AT the last meeting of the Berlin Anthropological Society Prof. Virchow stated that the German Colonial Society had sent circulars to all European colonies situated in the tropics requesting observations to be made regarding the question of the acclimatisation of Europeans in the tropics, the result of this inquiry to be communicated to the German Naturalists' Association at their next annual meeting in September. An exhibition of objects required in fitting out scientific travellers for their journeys will also be held at the same time as the meeting of German naturalists.

THE Ben Nevis Weather Reports chronicle an extraordinary dryness of the air in the end of last week. From 3 a.m. of Thursday the air became so dry that a humidity of about 15 per cent. was maintained for some time, and the dew-point fell to $-24^\circ\cdot0$. On Friday the humidity was about 13 per cent. till 3 p.m., when the air became still drier, and at 9 p.m. the humidity was only 8 per cent., the readings at this hour being: dry bulb, $19^\circ\cdot2$, and wet bulb, $13^\circ\cdot0$. The great dryness ceased at midnight, when the air suddenly became saturated. The snow lying at the Observatory at present is not much more than half the quantity of the two previous winters at this season.

IT is reported that on Sunday night, about 11 o'clock, a sharp shock of earthquake, lasting seven seconds, caused a panic at the theatre in Granada. The audience rose, and rushed into the streets. The inhabitants, awakened by the shock, poured out of their houses, and many persons remained in the streets and squares part of the night. Very little material damage was done to the houses, and none to the public buildings, for the preservation of which the authorities have adopted precautions. The shocks were oscillatory from west to east, and accompanied by a rumbling noise. The shock was felt also in the districts which were the scene of the earthquake of 1884. The villagers were terribly alarmed, and some houses were injured.

A VIOLENT shock of earthquake was felt at Wiesbaden at twenty-eight minutes past midnight on Sunday.

THE fourth volume of Dr. M. C. Cooke's "Illustrations of British Fungi" is just completed, bringing the total number of coloured plates up to 622, illustrating 790 species and varieties of *Agaricus*, or more than double the number figured by Fries in his "Icones," and nearly as many as there are in the combined works of Sowerby, Hussey, Bolton, Bulliard, and Krombholz. It is estimated that the two volumes yet to be published, if the author receives sufficient support, will contain about 400 additional species, making a total of nearly 1200 species and varieties of the gill-bearing *Fungi*, or nearly three times as many as in any other work in existence. The four volumes accomplished represent five years' laborious work and a great expenditure of money by the author, who is publishing at his own sole cost; yet we are assured that he has not only derived no profit therefrom, but has suffered a loss, and this in spite of his having saved the expense of an artist. Surely there must be a sufficient number of persons in this country interested in botany to render such a work self-supporting, if not remunerative; especially as the price is about half that of contemporaneous Continental works on the same subject. Dr. Cooke, in response to numerous solicitations, also proposes issuing a volume of coloured plates of British Desmids as a supplement to his "British Fresh-Water Algæ," provided a sufficient number of subscribers come forward.

NEAR the village of Dorndorf (Prussian province of Nassau) considerable alarm has recently been caused by the repeated appearance of extensive fissures in the surface of a hill. Quite lately the main fissure has advanced to within 100 metres of the village, at which point it, however, turned aside, seemingly returning to its starting-point. Subsidence of the soil has also been noticed in several parts of the circumscribed area, which measures about a mile in diameter.

THE climate of Lucerne has been described by Herr Suidter (in a recent address there) on the basis of five years' observations at Mariahilf. Lucerne, he says, is in the föhn-climate, but on the outer edge of its zone (the föhn being, it is known, a strong, warm, descending wind of southerly direction in Switzerland). The former is proved by the preponderance of warm winds and the large rainfall (average 1275·8 mm. in 1879–83) compared with Central Switzerland, the latter by the low mean annual temperature ($8^\circ\cdot284$ C.), and by a much less rainfall than places near the source of the föhn, such as (in descending order) Rigikulm, Vitznau, Schwyz, and Engelberg; where the föhn blows much oftener and more continuously and strongly. A peculiar green tinge of the sky's blue over the Uri or Obwaldner Mountains tells the Lucerners of the föhn's coming, some 12 to 24 hours in advance. Drenching rain nearly always comes with it. The lowest temperature in those five years was -17° C. (in 1879); but years often pass without the thermometer going down to $-10°$ or $-15°$. In the cold winter of 1879 the arm of the lake never became unnavigable from ice, and the robust exotic plants in the open gardens were scarcely damaged at all. The vegetation of Lucerne is much more southerly than the mean annual temperature of 8°·284 would lead one to expect. It is an interesting fact that as early as 1598 there was in Lucerne a small botanic garden (formed by Renward Cysat), where many exotic plants, such as tobacco, were grown, and from which issued the best methods for cultivating fruit-trees, &c.

THE curious phenomenon of "lake-balls" is to be met with on the Sils Lake and others in the Upper Engadine. They are composed of larch-leaves felted together. Three samples (the largest over a foot in diameter) were recently exhibited by Herr Coaz at the Berne Naturalists' Society, and he stated that these balls are formed in small bays into which the prevailing south-west winds blow. The water acquires a whirling motion, and the larch-leaves involved in it, together with pieces of moss, &c., are worked into balls. There is no cementing with mud. Sometimes, on shallow banks—not in bays—sausage-like forms are met with. Prof. Fischer made reference to another kind of lake-balls formed of a filamentous alga in the lakes of Sweden and other countries; also to the marine balls, formed of fragments of phanerogamic sea-plants (Zostera, Cymodocea, &c.) which were at one time used medicinally.

AT the last meeting of the Seismological Society of Tokio, Prof. Milne read a paper describing the results obtained from a seismic survey of the ground in the neighbourhood of his house. By the seismic survey of a district he meant an examination of the different parts of that district with regard to the effects which were produced upon them by earthquakes. After describing local peculiarities of the ground, he said that he placed at different places, but in similar positions, similarly constructed seismographs. These had been proved to give diagrams which were practically absolute measures of the movements of the ground, and, when any of these instruments were placed side by side, they gave similar results. The result of observing many earthquakes was that all the instruments, the positions of which would be included in a triangle the sides of which were 800 or 900 feet in length, gave different indications as to direction, amplitude, maximum velocity, and intensity. So that, had these instruments been in the hands of different observers, each observer would have given a different account of the same earthquake. Thus, comparing the average maximum velocities at a station, C, on hard ground, with that at a station, E, on soft ground, they were found to be 1 : 5. The maximum accelerations at these two stations were 1 : 2·4. It might therefore be concluded that a building at C would withstand a disturbance which would be sufficient to shatter a similar building placed at E. Prof. Milne also described further experiments made with a seismograph placed in a pit 10 feet deep, and with a wooden building the foundations of which at first rested on 10-inch cannon-balls, and subsequently on cast-iron shot 6 mm. in diameter.

ALL these experiments were made with a view to discover the best method of constructing buildings which would stand earthquake shocks with least damage. The practical conclusion of the investigation was that there were three ways by which residents could escape from very much of the motion which disturbs an ordinary building. These were (1) by a seismic survey they might select a site where there was relatively little motion; (2) they might build up from the bottom of a pit, which might be utilised as a cellar, the walls of the houses not touching the sides of the pit; (3) when obliged to build on soft ground, when a pit could not be excavated, a light one-storied building of wood or iron might be rested on a layer of cast-iron shot.

WE have received from Dr. D. J. Macgowan, whose name has for many years been well known to all students of China, a copy of a curious paper by him on the movement cure in China, contributed to the *Medical Reports* of the Chinese Customs. In form the paper (which contains several interesting illustrations of the *modus operandi* of the cure) is a notice of successive writers on the system of therapeutics, which was actually practised on the late Empress by a high official who was supposed to be an adept in the art. The notion that supernatural power was imparted to the human frame, and that the latter was rendered invulnerable to disease and death, by breath-swallowing, or accumulations of air in the system, is a very old one. About the sixth century before our era a celebrated writer recommended a mild form of exercise to effect this, and this exercise, with breath-gulping, now constitutes the Chinese movement cure. After tracing the fluctuations of the practice and their causes, Dr. Macgowan comes to a work published in 1858 by the high official already mentioned. Life, it is taught, depends on the existence of a primary aura; so long as a particle of it is retained in the system, death cannot occur. A deficient supply is the cause of disease; and when it duly permeates the system, every ailment is averted. The object of the postures, motions, and frictions is to promote the due circulation of that vital air. One writer illustrates the state of the system that is thoroughly saturated with air by that of a drunken man who falls from a cart without sustaining injury, because of intoxication; so a man permeated with the vital aura is invulnerable. Disease appears only when the vitiated air can find entrance, when the circulation of the vital air is defective. The air starts in its circulatory movement from the "little heart," which is situated in the pubic region; air-vessels convey it thence upward anteriorly to the forehead, where these vessels become continuous with a similar system that returns the air posteriorly to the "little heart." Without fire this aura is the source of animal heat; without water it lubricates the viscera. Fate, indeed, determines longevity as it does birth, yet disease may be averted by employing the movement cure, which is preferable to delaying until disease sets in, when the art is comparatively useless. These are the principles on which the cure rests.

THESE curious searchings into the mysteries of life and death are followed by a description of the details of the process. These are too numerous and complicated to be mentioned at length. They deal with the periods of air-swallowing and friction, the time for inhaling the sun's air and the moon's air, the time and modes of friction, the implements for shampooing (amongst them being a bag filled with water-worn pebbles, and a pestle or round bat for pounding the abdomen), and the various muscular movements, many of which are exceedingly comical. In gulping air the east should be faced, and twelve of the various operations described should be gone through each forty-nine times. In going through the exercises there is to be no thinking, for the mind must be absolutely quiescent. Reference to this air-swallowing is made in the earliest extant Chinese medical treatises, but regular practitioners have always regarded the exercises as charlatanism.

MR. HOWARD GRUBB, F.R.S., will give the first of two lectures on the Astronomical Telescope on Saturday (March 27), at the Royal Institution; and on Friday (April 2) he will give a discourse on Telescopic Objectives and Mirrors: their Preparation and Testing.

M. GASTON TISSANDIER has issued the prospectus of a large work which he is preparing on the great aëronauts. The work will be in two volumes, the first of which is to appear next October.

THE additions to the Zoological Society's Gardens during the past week include a Silky Marmoset (*Midas rosalia*) from Brazil, presented by Mr. Percy Bewick Bewick; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mrs. Dunn; a White-crowned Mangabey (*Cercocebus æthiops*) from West Africa, presented by Mr. N. King; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. W. A. Rooff; a Black-backed Jackal (*Canis mesomelas* ♀) from South Africa, presented by Mrs. E. Thomas; a Grey Ichneumon (*Herpestes griseus* ♀) from India, a Demoiselle Crane (*Grus virgo*) from North Africa, presented by Mr. T. W. Proger; a Moor Monkey (*Semnopithecus maurus* ♀) from Java, deposited; a Talapoin Monkey (*Cercopithecus talapoin* ♀) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN

DARK TRANSITS OF JUPITER'S FOURTH SATELLITE.—Prof. Davidson, of the U.S. Coast Survey, has communicated to the Californian Academy of Sciences some interesting notes of observations of "dark" transits of Jupiter's satellite IV. made by Mr. Burckhalter with a $10\frac{1}{2}$-inch reflector. Mr. Burckhalter's observations on May 21, 1885, suggest the possibility that the satellite has an area of white surface and also an area of dark surface. When the satellite approached the planet it appeared bright, the white area being then the visible part; but when it had advanced some way on the disk, this white part was (on this supposition) lost in the superior brightness of the planet, and the dark area became visible. Prof. Davidson thinks it might even lead to the determination of the rotation period of the satellite if it were watched throughout the whole transit, and the different phases noted. Again, observing on June 7, 1885, Mr. Burckhalter saw the satellite as a dark spot on the edge of the north dark belt. But as soon as the satellite was clear of the planet's disk, it was noted to be north of this belt; so that it would appear from this observation also as if the satellite were divided into bright and dark areas, the south pole being the dark one. Prof. Davidson also observed the transit of June 7 with a 6·4-inch refractor, and confirms generally the appearances noted by Mr. Burckhalter.

NOVA ANDROMEDÆ OF 1885, AND NOVA SCORPII OF 1860.—With reference to Prof. Seeliger's researches on the subject of the Nova in Andromeda (NATURE, vol. xxxiii. p. 397), Herr Auwers draws attention in the *Astronomische Nachrichten*, No. 2715, to the great similarity of this outburst to the phenomenon observed by him in 1860 in the nebula 80 Messier in Scorpio. He considers that the probability that, in an interval of twenty-five years, two variable stars of so exceptional a character should be projected on the central part, in one case of a close star-cluster, in the other case of an object which appears to be, in part at least, a close star-cluster, is so small that the identity of the circumstances attending the phenomena of 1860 and 1885 makes it almost necessary to refer both outbursts to physical changes in the nebulæ in which they respectively appeared. As Prof. Seeliger makes no mention of this (in Herr Auwers' opinion) very strong argument in favour of his supposition respecting the cause of the outburst in Andromeda, Herr Auwers is induced to do so, and takes the opportunity of publishing the details of his observations of the Nova of 1860, an account of the discovery of which was printed in the *Astronomische Nachrichten*, No. 1267. Herr Auwers states that having turned the Königsberg heliometer on 80 Messier on the evening of May 21, 1860, he saw a 7th magnitude star in the nebula, a little following the central part, which it quite outshone in brilliancy. By June 16 this star had degraded to magnitude 10·5. It will be remembered that the "new" star in Scorpio was independently discovered in this country by Mr. Pogson, whose attention was arrested on May 28, 1860, "by the startling appearance of a star of the 7·6 magnitude in the place which the nebula had previously occupied." On June 10, according to this observer, the stellar appearance had nearly vanished, but the cluster still shone with unusual brilliancy and a marked central condensation.

FABRY'S COMET.—The following ephemeris, by Dr. H. Oppenheim (*Astr. Nach.* No. 2711) is in continuation of that given in NATURE for 1886 March 4:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ	Brightness
March 23	23 16 58	36 5·6 N.	9·8421	0·0589	20
27	23 16 57	37 12·4	9·8233	0·0203	26
31	23 17 59	38 11·5	9·8102	9·9744	34
April 4	23 20 55	38 58·9	9·8043	9·9198	45
8	23 27 4	39 28·7	9·8062	9·8547	61
12	23 38 33	39 31·4 N.	9·8157	9·7767	83

The brightness on December 2 is taken as unity.

BARNARD'S COMET.—The following ephemeris, by Dr. A. Krueger (*Astr. Nach.* No. 2710), is in continuation of that given in NATURE for 1886 March 4:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ	Brightness
March 22	1 51 49	27 34·3 N.	0·0217	0·2230	7·12
26	1 51 13	28 57·0	9·9917	0·2144	8·51
30	1 50 34	30 23·2 N.	9·9594	0·2036	10·38

The brightness on December 5 is taken as unity.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *MARCH* 21–27

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 21

Sun rises, 6h. 1m.; souths, 12h. 7m. 15·4s.; sets, 18h. 13m.; decl. on meridian, 0° 19′ N.: Sidereal Time at Sunset, 6h. 10m.

Moon (one day after Full) rises, 18h. 50m.*; souths, 0h. 53m.; sets, 6h. 45m.; decl. on meridian, 2° 35′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 19	13 12	20 5	9 40 N.
Venus	4 23	9 43	15 3	8 37 S.
Mars	15 54	22 55	5 56*	11 11 N.
Jupiter	18 4*	0 13	6 22	0 59 N.
Saturn	9 59	18 11	2 23*	22 48 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
23	γ Libræ	$4\frac{1}{2}$	23 19	23 58	93 167
24	η Libræ	6	4 18	5 34	75 285

March	h.	
21	19	Jupiter in opposition to the Sun.
22	2	Mercury at greatest elongation from the Sun, 19° east.
25	—	Venus at greatest morning brilliancy.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Mar. 23,	19 35	*m*
Algol	3 0·8	40 31 N.	,, 21,	1 7	*m*
			,, 23,	21 56	*m*
R Aurigæ	5 8·1	53 27 N.	,, 22,		*m*
ζ Geminorum	6 57·4	20 44 N.	,, 25,	4 50	*M*
U Monocerotis	7 25·4	9 32 S.	,, 21,		*M*
δ Libræ	14 54·9	8 4 S.	,, 25,	21 18	*m*
T Libræ	15 4·2	19 35 S.	,, 24,		*M*
U Coronæ	15 13·6	32 4 N.	,, 23,	2 29	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 24,	4 40	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Mar. 24,	0 0	*m*
			,, 26,	21 30	*M*
W Sagittarii	17 57·8	29 35 S.	,, 22,	2 20	*M*
T Herculis	18 4·8	31 0 N.	,, 24,		*M*
β Lyræ	18 45·9	33 14 N.	,, 22,	2 20	*M*
R Cygni	19 33·8	49 57 N.	,, 22,		*M*
η Aquilæ	19 46·7	0 7 N.	,, 25,	0 0	*M*
δ Cephei	22 24·9	57 50 N.	,, 22,	19 10	*m*

M signifies maximum; *m* minimum.

BIOLOGICAL NOTES

THE PELAGIC STAGES OF YOUNG FISHES.—The memoirs by Alex. Agassiz, on the young stages of osseous fishes, have been noticed from time to time in our pages. In connection with C. O. Whitman, he has quite recently published, as the first part of vol. xiv. of the *Memoirs* of the Museum of Comparative Zoology at Harvard College, an account of the pelagic stages of young fishes, which is illustrated with nineteen very beautifully-executed plates. This memoir is devoted to descriptive sketches of the different fish-eggs which have come beneath the notice of the authors, and of the early stages of the fish after their escape from the egg. In a second portion of the memoir it is proposed to treat of the earlier stages of cleavage, the formation of the embryonic ring, the formation of the various portions of the embryo, and so on. The pelagic eggs, so far as the authors' experience goes, may be divided into—(1) those without oil-globules, and (2) those with one or more oil-globules. But this, while a convenient, is not an accurate division, because, if eggs apparently without oil-globules are carefully examined, the yolk-mass will be found permeated with minute fatty bodies, but these are never seen to coalesce to form conspicuous oil-globules. Some pelagic eggs are laid singly—this seems to be the most common condition—and are left to float at the mercy of the waves and winds, while others are laid in an investing gelatinous mass. The single eggs seem to have the best chance of escape from their numerous enemies, while as to those laid in masses the chances seem all against them. When first laid, pelagic eggs are usually perfectly transparent; little by little, with the formation of the embryo, chromatophores are formed, generally upon the surface of the yolk-mass close to the embryo, or upon the embryo itself. These chromatophores, at first colourless, soon become pigmented, and while the young embryo is still within the egg, the characteristic colour-pattern is often clearly indicated. All the eggs described in the memoir, except when confined in masses, float with the embryo downwards. The resorption of the yolk-mass differs greatly in the different species. The rate of resorption also varies, and would seem to be correlated with the degree of development of the structural features of the embryo. The chromotaphores very rarely become dendritic before the embryo is hatched, and as a rule not till then does the black eye-pigment make its appearance. The first fins formed are the pectorals, traces of which appear in very early stages within the egg. The closing of the blastopore and the disappearance of the vesicle of Kupffer are followed by the growth of the tail and the formation of an embryonic caudal fin. Usually at the time of the resorption of the yolk-mass the pectorals are well developed, and have become powerful limbs; then, too, the intestinal tract lengthens, and a swim-bladder and larger alimentary canal appear. In the very youngest stages, immediately on leaving the egg, the embryo depends mainly upon its embryonic dorsal and ventral (its leptocardial fin) fin for locomotion. The propelling powers are proportionally very large, and at no time of its life is the young fish better provided with both means of locomotion and sense-organs. With growth the young fish depends, however, more and more for locomotion upon the use of its pectoral fins. The comparatively large size of the chorda in the earlier embryonic stages is a marked feature of all young fishes. The regularity with which the same stages of development of identical species appeared in successive years was very striking, and the authors note that this regularity was not peculiar to young fishes, but that they also found the spawning of the majority of marine animals and their rate of development practically identical year after year; as instances of the latter they refer to embryos of Agalma, Balanoglossus, Plagusia, &c. To facilitate the identification of the different pelagic stages of fish and fish-eggs, a table is given, in which we find the most characteristic features of the eggs and young fish so far as these have been observed, the date of their occurrence, the distinctive features at time of hatching, with references, so far as the forms described in this memoir are concerned, to its pages and its figures, and for the rest to authorities where they have been described. The figures on the plates are from sketches from life made by A. Agassiz and Whitman. We trust soon to be able to notice the second portion of this important memoir.

DANAIS ARCHIPPUS—AN ENTERPRISING BUTTERFLY.—As an instance of a species extending its geographical area under our observation, perhaps there is none more remarkable than the case of a beautiful and noteworthy butterfly whose natural history is so pleasantly written about in the *Entomologist's Monthly Magazine* for March 1886 by Mr. James J. Walker, R.N. We would that our British Navy had many more such excellent observers. This butterfly, which, according to the rules of zoological nomenclature, is called *Anosia plexippus*, L., is perhaps better known by its synonym, *Danais archippus*, F. The original home of this insect is the American continent, where, including some well-marked varieties, it now enjoys a vast range, extending from the Hudson's Bay Territory and Canada to the region of the Amazons, Bolivia, and the estuary of the Rio de la Plata. Nearly everywhere through this vast area it is common, and in some places it occurs in vast swarms. Thus Mr. Riley says that at Missouri the air is sometimes filled with these butterflies to a height of from 300 to 400 feet. These swarms appear in autumn, and some of them seem to migrate southwards to warmer regions at the approach of winter. The caterpillar is singularly hardy, handsome, and easy to rear; it feeds on various species of Asclepias, a genus belonging to one of the most interesting families of plants known. All the species of the genus are peculiar to the New World—and to the northern portions of it, just that area which seems to have been the birth-area of our butterfly—or to tropical Africa. Many of them are hardy even in this country, and are easily increased, taking care, as a gardener would say, of themselves. *A. tuberosa* is a fine border plant; *A. cornuti* has sweet-scented flowers; while *A. curassavica*, though bearing showy flowers, has a fœtid perfume, like its congeners, the Stapelias, those African Asclepiads so attractive to the carrion-flies; this last species is the one so fully described by H. Müller as fertilised through the agency of Lepidoptera. The chrysalis of *D. archippus* is described as very beautiful, being of a bright, translucent, emerald-green colour, with some transverse black ridges, brilliantly-gilded lines, and minute spots of a bright gold hue, and the duration of the pupal condition is from fourteen to twenty days. Insect-eating birds do not touch either larval or perfect forms, which are free even from Ichneumon guests. It is interesting to note that Mr. Riley has found the larva attacked by a Dipteron, this group of insects being intimately connected with the life-history of Asclepiads. The longevity of the imago is most remarkable. Taking all these facts into consideration, we find this butterfly well outfitted for the battle of life: the perfect insect strong on the wing, with from twelve to fifteen months of a life; eggs soon hatching, after being laid on the food-plants, these themselves spreading like weeds; larvæ not molested by destructive parasites. The first great march westwards was over 2350 miles to the Sandwich Islands, and remembering that the appearance of the insect here is subsequent to commerce with these islands, the probability is that it was helped across this expanse of ocean, and then it in a wonderfully steady and rapid manner spread across the whole breadth of the Pacific Ocean, and far into the Malay Archipelago. Carrying on its course round the world, we may soon expect to hear of it in Asia. Southwards and westwards it has appeared in New Zealand and Australia. After enterprise like this, it does not seem surprising that eastward it should have flown to the West Indies, and at least one or two examples to the Azores; and within the last ten years it has put in an appearance and been speedily captured in South Wales, Devon, Isle of Wight, Dorset, Sussex, and Kent. In 1879 a specimen was even taken at La Vendée. While as garden plants species of Asclepias are fairly common in Britain, in Europe other food-plants might be found in *Vincetoxicum officinale* and *Cynanchum acutum*. With such a startling phenomenon in distribution, which in so gay and fine an insect cannot easily be overlooked, a great light is thrown on the diffusion under perhaps even more favourable circumstances as to the distribution of less conspicuous species. We should have welcomed some remarks from Mr. Walker's pen about the varieties that may have arisen from the very varied surroundings that environ the butterfly; one of these, *D. erippus*, seems by some entomologists almost to take rank as an independent species; that is to say, that it has passed too far away from the type to be easily recognised as such.

GEOGRAPHICAL NOTES

THE following medals have been awarded by the Geographical Society of Paris for 1886:—The principal gold medal to MM. Capello and Ivens for their three journeys across Africa; gold medal to the Pandit (name not specified, but doubtless A——K) for his journey in Tibet; the Lagerot prize to M. Morsche for his explorations in the Philippines; a silver medal to M. Bloyet for his topography of Eastern Africa; and the bronze medal to M. Mager for his *Atlas Colonial*, published by M. Bayle.

ETHNOLOGISTS will be glad to know that the February number of the *Bolletino* of the Italian Geographical Society contains a full descriptive account of the objects forwarded to Europe by Romolo Gessi after his return to East Central Africa in 1877. These objects have now been added to the rich collection which he had already presented to the Geographical Society, and which has found a permanent home in the Prehistoric and Ethnographic Museum in Rome. Amongst the objects specified by Dr. G. A. Colini, to whom the public is indebted for this paper, mention is made of a stool from the Bongo tribe (Upper White Nile) with feet made exactly like the boots usually worn by European ladies. This object was locally known as "the lady," and it is suggested that the native artist took for his model the boots belonging to Miss Tinné. The artistic talent of the Bongos is, however, better illustrated by the figure of a man 0·69 metres high, wearing a girdle of cylindrical glass trinkets, and with upper lip and ears pierced for the insertion of the iron rings commonly worn by this tribe. From the Latuka people on the opposite or east side of the Nile come ivory trumpets, wooden clubs with iron heads, curious knives with slightly curved blade and wooden handle inlaid with iron plaques, and a very fine helmet decorated with shells, red and blue glass beads and a triangular brass plate in front. The A-Zandeh (Niam-Niam) and Mangbuttu (Monbuttu) objects are distinguished by their number, variety, and richness, including articles in wood, iron, and ivory: arms, ornaments, utensils, and musical instruments. The ivory carvings often display great taste in the designs and technical skill in the execution, fully bearing out the accounts of Schweinfurth and other travellers regarding the great artistic talent of these cannibal tribes. Archæologists will be interested to know that amongst the Mangbuttu objects is a splendid polished stone hatchet 0·25 metres long, with circular section, and terminating above in a point, which must be classed with the prehistoric hematite weapons supposed by the natives to have fallen from the clouds. Nearly all the tribes of the Upper Nile Valley, and even several of the equatorial lake region, such as the Waganda and Wanyoro, are represented in this very valuable ethnological collection, probably the most complete yet brought together from that quarter of the globe.

AT the meeting of the Paris Geographical Society of the 19th ult. Vicomte de Brettes described the results of an exploration made by him during last year in the southern Grand Chaco. Since the commencement of the sixteenth century forty-three expeditions have attempted to discover a communication between the regions on the eastern slope of the Andes with those on the left banks of the rivers Paraguay and Parana. These expeditions have constantly followed the courses of the Pilcomayo and Vermejo, and have ultimately demonstrated the impracticability of these routes by reason of the numerous rapids, as well as of the shallowness of the water. The route so actively sought for three centuries by the Argentine Republic, Bolivia, and Paraguay, which would increase their trade tenfold, has never yet been sought by land, and since the Spanish conquest the interior of the southern Grand Chaco has remained wholly unknown. M. de Brettes undertook this exploration, and entered the region accompanied only by two Chenupis Indians. He discovered three rivers and an immense salt lake, on the banks of which he marched 113 miles, when ague and fever compelled him to return to Corrientes after a journey of 436 miles in a hitherto-unexplored region. The country traversed by him is absolutely flat, mimosa-trees and palms grow in abundance, and there are vast prairies and swamps, inhabited by the Chenupis, Mocovis, Velelos, and Matacos—all tribes still in an extremely barbarous state. The lecturer referred to various unpublished documents respecting these tribes, including a grammar of the Topii language, which is in the press. He also announced his intention of returning to the Chaco to continue the work which was arrested by illness. He appears to have received the most cordial assistance from the Argentine authorities.

ON February 12 General Prjevalsky gave a lecture on his fourth journey to Central Asia before a distinguished audience at St. Petersburg. He entered into details on the sources of the Yellow River, and described the environs of Lob-nor, dwelling upon the peculiar features of the population of the surrounding country. Then the lecturer passed to the orographic outlines of the Alpine country, the numerous chains of which had been first traced by himself, and finally concluded his account by describing the valley of the River Tarim. The lecture was very well illustrated.

THE March number of the *Proceedings* of the Royal Geographical Society has for its leading paper an account, by Col. Stewart, of the Herat Valley and the Persian border, from the Hari-rud to Sistan. It contains a large amount of interesting information respecting a region which appears destined to play a larger part in the public eye of England in the future than even in the past. The discussion which followed adds much to the paper, and this is especially the case with the remarks of Surgeon Aitchison, the naturalist to the Afghan Delimitation Commission, who read an account of the botany of the region. Major Greely's lecture on Arctic exploration with reference to Grinnell Land is also published. The number also contains summaries of two lectures, and the subsequent discussions, at the Exhibition of Appliances used in Geographical Education, the lecturers being Profs. Bryce and Moseley.

THE March number of the *Scottish Geographical Magazine* commences with a paper by Col. Stewart on a visit to Badghis in 1883, and to the Herat Valley in 1885. It also contains a paper by Prof. James Geikie on mountains—their origin, growth, and decay; and a brief account of Dr. Boas's recent journeys in Baffin Land. The geographical notes are very comprehensive; amongst them is one, taken from the *Geographischer Jahrbuch*, 1885, containing statistics of the geographical societies of the world. It is somewhat humiliating to find Great Britain and her colonies only third on the list in point of members, and fifth in the number of societies. France has 26 societies with 18,000 members; Germany 24, with 9300 members; while the British Empire has 5 societies, with 5300 members. The United States is even worse, for it has only 2 societies, with 1500 members.

AT the last meeting of the Geographical Society of Paris, M. Hansen-Blangsted read a note on the disagreement between geographers as to the highest peaks in Denmark. According to the maps of the general staff at Copenhagen, the highest hills were in the south-west of the department of Aarhus. Himmelberg was long regarded as the principal eminence in Denmark; it is 147 metres in height. But in the forest of Ky, in the south of the commune of the same name, there are several unnamed heights, one of which is 163 metres high. Himmelberg is now only the third in height, and possibly it will have on examination to take even a lower place. Communications were read from Gen. Annenkoff on the Transcaspian Railway and the region it traverses, from M. Thouar on his exploration on the Pilcomayo, and from M. Duveyrier on some Sahara longitudes.

IN the last number of the *Transactions* of the Halle Verein für Erdkunde, Herr von Brandis describes some curious observations which he made during a year's residence in 1861-62 on the slope of the active Java volcano Merapi, which has lately been in eruption. From the crater two perfectly straight white columns of steam (not smoke), of equal thickness above and below, ascended. For some weeks the colour was of an equal degree of whiteness throughout; both were of equal height, and from measurements made this varied from 320 to 450 metres. The upper ends were cut off sharply like the ends of two tapers, and the thickness of one varied from 5 to 15 metres, while the other was only about half this. The distance between the two appeared to be about 20 metres. The colour of the smaller of these pillars appeared to alter occasionally, but the wind did not seem to have any effect in causing them to deflect from the perpendicular. At first the observer thought there must be perpetual calm at this altitude; but this is not so, for others have found that a south-east wind blows constantly there. The effect of a current of air blowing from this direction would have been readily perceptible to Herr von Brandis in the position his residence occupied. This curious phenomenon was observed in 1836 by Junghuhn, of Madgeburg, who ascended the mountain, but the conditions of the summit do not appear to have been sufficiently investigated to enable a positive explanation of it to be made.

IT is stated that M. Rogozinski, who is at present in Cracow, is preparing a dictionary and grammar of the idioms of the Cameroon tribes.

M. ROLLAND has been charged by the French Minister of Public Instruction with a mission to Madagascar, to study its mineralogy, botany, zoology, and anthropology.

THE SUN AND STARS[1]

III.

The Spots

IN the large photographs now secured at Meudon and in India, and smaller ones now received from India, the Mauritius, and Australia, showing the spots as they are photographed there, I am glad to say almost every day now, on a scale of 8 inches to the sun's diameter, we get wonderful records of what a spot really is, and how it changes.

In a normal spot the exterior shade is called the *penumbra*. The inner darker one is called the *umbra*, and very often there is a deeper shade still, which is called the *nucleus*. In some spots there are many umbræ for one penumbra; and very likely, if one had examined them carefully with the telescope at the time, one would have found that each had its interior nucleus. The idea is that we have at the edge of the penumbra, where the penumbra joins the photosphere, the greatest height of the spot; that the penumbra is an incline going down as gradually as you like, but still down, so that the level of the photospheric stuff, whatever it is, at the edge of the umbra, is below what it is at the edge of the penumbra.

In the penumbra the domes seen on the general surface are drawn into elongated shapes, hence we speak of the "thatch" on the penumbra. Visually the part of the penumbra adjoining the umbra seems brighter than that adjoining the photosphere. In photographs this is not so.

Now, if the view that the spots are cavities be correct, and the appearances they put on in travelling over the sun are sufficient to prove it, it will be clear that there ought to be occasions when a spot going over the limb should show as a depression. The idea that sunspots are cavities is a very old one. It was first put forward by Wilson of Glasgow in the last century; but it was not so easy to demonstrate it to a large audience in the days when one had no photographs.

FIG. 4.—Appearances presented by spots. A is the centre of the disk; B between centre and limb; C, near the limb.

Here is a photograph showing the retreat of a sunspot over the edge of the sun in 1884. We see that it writes its record in an unmistakable notch at the limb of the sun (Fig. 5).

In other photographs we can conveniently study the connection between the faculæ and the spots, especially if the spots be near the limb; the neighbourhood of spots in this position is very rich in faculæ.

When we come to examine these spots carefully, we find that there are apparently in the main—(I want to speak as guardedly as I can)—two different kinds. Some spots seem to be pretty regular, and to undergo no very violent commotion. I mean that the penumbra and the umbra are not so tremendously contorted and mixed up as sometimes happens; and, again, the ridge of facula round the spot is not so honeycombed by convection-currents and the results of convection-currents. On the other hand, as representing the other class where we get violent action, there seems to be no limit to the enormous energies indicated, and the areas over which these energies hold their sway. I believe that one spot, or at least a spot system, was observed in 1858, of 140,000 miles or eighteen earth-diameters in length. Telescopic examination of each minute part of these enormous disturbances indicates that the most violent changes are going on—changes which the eye can detect, after a few minutes' interval, in different parts of the spot (see Fig. 6).

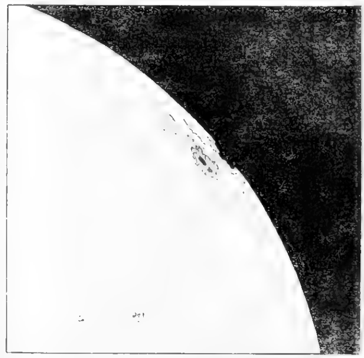


FIG. 5.—Copy of part of a photograph taken at Dehra Dun in 1884, showing a sunspot passing over the Sun's edge.

The History of a Spot

A spot seems to be the first disturbance of the photosphere in the region where it is formed. I mean *the facula follows, and does not precede, the spot.* On this point I first quote Dr. Peters,[1] one of our highest authorities:—

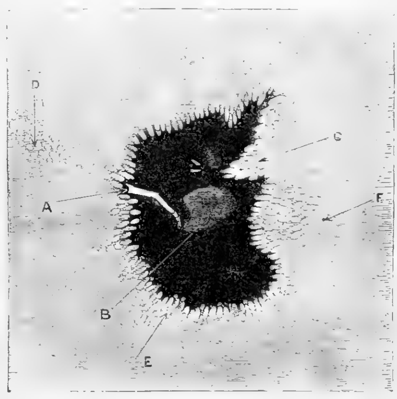


FIG. 6.—Sunspot showing details of the penumbra. The dark portion in the centre is the umbra, the surrounding half-tone is the penumbra. A, a "bridge" or tongue of facula being carried over the umbra; B, clouds forming at the end; C, part of the penumbra being driven over the spot (the domes are drawn out); D, domes on photosphere; F, "thatch" on penumbra.

"The spots arise from insensible points, so that the exact moment of their origin cannot be stated; but they grow very

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 429.

[1] *Proceedings* of the American Association for the Advancement of Science, vol. ix.

rapidly in the beginning, and almost always in less than a day they arrive at their maximum of size. Then they are stationary, I would say in the vigorous epoch of their life, with a well-defined penumbra of regular and rather simple shape. So they sustain themselves for 10, 20, and some even for 50 days."

I next quote the Rev. S. J. Perry, one of the most constant of modern solar observers:—

"And, to begin with spot-formation, we find almost invariably that large solar spots start life as little dots, frequently in groups, and then grow at once with enormous rapidity. A spot will often attain its full size in 5 or 6 days, although exceptionally large ones occasionally occupy a longer time in their first development. If no remarkable increase is noticed in a spot within 2 or 3 days from its birth, it will in all probability never attain to any considerable size. The solar surface has repeatedly been examined with the greatest care, in regions where considerable spots have broken out on the following day, without detecting any marked disturbance or other sign announcing a probable outburst. No satisfactory exceptions to this have as yet been noticed."

The second state of a spot's history presents us with phenomena of reaction, as if the material carried in the first instance below the upper level of the photosphere had produced a disturbance in the lower regions, indicated by the increase in the quantity and brilliancy of the faculous matter and its separation into small masses, while at times the umbra of the spot becomes distinctly coloured.

I again quote Dr. Peters:—

"The notches in the margin, which, with a high magnifying power, always appear somewhat serrate, grow deeper, to such a degree that the penumbra in some parts becomes interrupted by straight and narrow luminous tracts,—already the period of decadence is approaching. This begins with the following highly interesting phenomenon. Two of the notches from opposite sides step forward into the area, over-roofing even a part of the nucleus; and suddenly from their prominent points flashes go out, meeting each other on their way, hanging together for a moment, then breaking off and receding to their points of starting. Soon this electric play begins anew and continues for a few minutes, ending finally with the connection of the two notches, thus establishing a bridge and dividing the spot into two parts. Only once I had the fortune to witness the occurrence between three advanced points. Here from the point A a flash proceeded towards B, which sent forth a ray to meet the former when this had arrived very near. Soon this seemed saturated, and was suddenly repelled; however, it did not retire, but bent with a sudden swing toward C; then again, in the same manner, as by repulsion and attraction, it returned to B; and, after having thus oscillated for several times, A adhered at last permanently to B. The flashes proceeded with great speed, but not so that the eye might not follow them distinctly. By an estimation of time and known dimension of space traversed, at least an under limit of the velocity may be found; thus, I compute this velocity to be not less than 200,000,000 metres [or about 120,000 miles] in a second.

"The process described is accomplished in the higher photosphere, and seems not to affect at all the lower or dark atmosphere. With it a second, or rather a third, period in the spot's life has begun, that of dissolution, which lasts sometimes for 10 or 20 days, during which time the components are again subdivided, while the other parts of the luminous margin, too, are pressing, diminishing, and finally overcasting the whole, thus ending the ephemeral existence of the spot.

"Rather a good chance is required for observing the remarkable phenomenon which introduces the covering process, since it is achieved in a few minutes, and it demands, moreover, a perfectly calm atmosphere, in order not to be confounded with a kind of scintillation which is perceived very often in the spots, especially with fatigued eyes. The observer ought to watch for it under otherwise favourable circumstances when a large and ten- or twenty-days'-old spot begins to show strong indentations on the margin."

The scintillation referred to by Dr. Peters is perhaps associated with a phenomenon which has been described by M. Trouvelot,[1] who has observed the faculous masses to subdivide into small flakes which vibrate rapidly, producing the effect of a snow-storm above the umbra, when these dissolve into blue or violet vapours.

It happens sometimes also near groups of spots which are endowed with great activity that perturbations are observed which are so violent that the adjacent photosphere is shaken to its foundations, cracks, and, on opening, forms sinuous crevasses which extend to considerable distances, sometimes connecting the most distant spots with each other.

[1] *Bulletin Astronomique*, vol. ii.

From the instant of their apparition the crevasses—even those which are the narrowest—show a striated and filamentous structure, which presents the greatest analogy with the penumbræ of spots; only, instead of inclining and forming a sort of slope like that on the penumbra, the filaments which form entirely the sides of the crevasses are vertical, and are all directed towards the centre of the sun.

When these crevasses have a certain duration they widen sometimes here and there, especially when they bifurcate and send branches in another direction. In this case it is not rare to see forming a strait and lengthened umbra when, at the same time, the vertical filaments having now more room raise their lower extremities.

We have seen that the last act in the history of a spot is its invasion by the faculæ. These faculæ remain long after the spot has entirely closed up, and in this connection it is important to remark that new spots very often break out in the old place. These of course, unlike the first spot in that position, will appear to be preceded by faculæ.

There is a great deal more that I might say about spots. It is a very tempting subject, but there is so much more to be referred to. The papers which have recently been printed by the Rev. S. J. Perry[1] and M. Trouvelot represent some of the most careful modern examination of the solar surface, and there is really a very great deal to be learnt from them; and fortunate it is that much which this new work has brought out in the plainest way has reference to a region of fact of very great importance to any one who wants to be able to answer for himself, as well as he can, the question, What is a sun? For instance, M. Trouvelot discovered about ten years ago that, although, as we shall see presently, ordinary sunspots have a very definite place of their own on the sun, there is a kind of spot which is not so confined. These he calls veiled spots; and I gather from his description that his opinion is that the photosphere is driven down there to a certain extent, but not driven down sufficiently to give us the dark appearance which we get in the other cases.

Spots caused by Descent of Cooled Material

It has already been suggested in preceding paragraphs that in the spot region we cannot really be dealing with any violent changes of pressure, but we may be dealing with very violent changes of temperature. We can see that it is the most natural thing in the world to suppose that in an atmosphere like the sun's, seeing that there is enormous radiation, and therefore cooling at the exterior, there must be a descent of solid particles into the interior heated region. Now, can we associate this with spot phenomena?

Yes, we can, and we are absolutely driven to it. We have already seen that the spot, when it travels over the limb, is a hollow. We also find when we examine a spot with the spectroscope that certain vapours get very much denser, as if they were being crushed together into a certain limited region either by an upthrust or a downfall. Which? Well, the spectroscope answers that question for us quite perfectly, because it shows that the vapours are absorbing, and therefore that they are cooler than the photospheric material immediately underlying them, and that they have not an excess of radiation, as they would have if they came up from below; the spectroscope then certainly justifies the view that a spot is really the result of a downrush; the vapours there are *cooler*, as they should be if they come from a cooler place; they are *denser*, as they should be, if they are descending rapidly into a place which is more or less confined; and, more than all, the change of the refrangibility of certain lines enables us to determine roughly the rate at which these descents take place. A very common velocity is 30 miles a second—not 30 miles a minute or 30 miles an hour, but 30 miles a second.

Our final idea with regard to the spots then is that they are depressions, that in fact we may regard them as shallow saucers or cups filled with the cooler vapours brought from the upper regions of the solar atmosphere. This is merely a physical conception. What we have next to do, if possible, is to add a little

[1] In the *Astronomical Register*.

chemistry, to make a more or less detailed examination of the materials—of the various chemical substances—in them.

The Chemistry of the Spots

Now from what has been already said we at once see that if we get a downrush of solid bodies, such as cooled iron masses which are derived from the condensation of the iron vapour, and which we may regard as solar meteorites, from the top of the sun's atmosphere down to the photosphere, we shall have, if that quantity be great enough in the spot region, a considerable dimming of the sun's light, by reason of the fact that we have an infinite number, or a very large number, of solid bodies stopping the light from that particular part of the sun. We shall have in that way then a continuous absorption of the sun's light; that is to say, the red light, the yellow light, the green light, the blue light, and so on, will all be more or less stopped, and that part of the sun will, from that cause alone, look dimmer. Further, if we have any vapour approximating in molecular structure to the chlorine vapour to which I drew your attention before, we shall have an absorption of another kind; we shall have a special stopping of the blue light of the sun, making, therefore, the sunlight yellower than it otherwise would be. Again, if we have other substances associated with these spots in the state of fine vapour in a state of incandescence, we shall have such absorption indicated by the darkening of certain of the Fraunhofer lines, and by the widening of them as well as the darkening of them if the quantity of any particular vapour is considerable, and we shall also get new lines if new substances are produced or their existence revealed by these conditions.

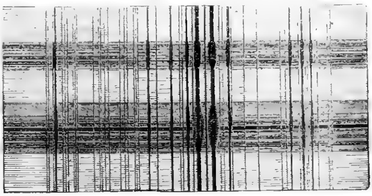


FIG. 7.—The spectra of two sunspots, showing the general darkening, and that certain lines are widened while others are not.

Now, I propose with regard to this point, seeing that our time is limited, to confine myself to the observations that have been made on the sun's spots at South Kensington since the year 1879. From that period some 700 spots have been observed. Of that number some 200 have been discussed; that is to say, maps have been made, and we have endeavoured to see along which line it was best to push on the work. But this climate of ours is not a particularly good one for observations of this kind, especially in London, because there is a good deal of smoke, and it is almost as difficult to see through a smoke cloud as it is through one of the ordinary kind. Still, in that time a considerable number of observations have been made altogether; and, to guarantee us as far as possible against bad climatic conditions, what has been done in the case of each spot has not been to observe all the lines which are specially affected, but to content ourselves with getting the results with regard to twelve lines, six in the green and yellow, and six in the blue. In that way, as these observations can be recorded in about an hour, all the observations made from 1879 to the present time are strictly comparable.

Before I state exactly what results we did get it is worth while for one moment to consider what results we should get if the old view of the chemical structure of the solar atmosphere were correct. This view is that most of the absorption which produces the Fraunhofer lines in the solar spectrum, especially those due to the absorption of the vapours of chemical substances of high atomic weight, takes place close to the photosphere, which is practically the place where the spots live. Therefore we should expect to see:—

(1) The same lines constantly thickened, as the ordinary solar spectrum is constant.

(2) The same lines of a substance widened in all spots, in which we have evidence that that particular substance is present, or the lines thinning out in all cases in the same order.

(3) No lines but those visible in the general spectrum.

(4) Motion indicated by one line of a substance indicated by all.

If the old view were true, that we have iron vapour among the other vapours in the atmosphere of the sun—nickel vapour, magnesium vapour, and so on, it would not be at all out of the way to suppose that some spots might chiefly consist of iron vapour, whereas another spot might be chiefly filled with nickel vapour, or with magnesium vapour, and so on.

With reference to (2) it may be explained that in the case of a spot which we can imagine to contain a very large quantity let us say of iron vapour, and a very small quantity of magnesium vapour; by a laboratory process which had been worked out before this work was commenced, it was easy to make a rough, but still a very useful, quantitative guess as to their relative proportions, because it has been found in laboratory work that if we only have a very small quantity of one vapour, let us call it vapour *a*, in a mixture of other vapours, *b*, *c*, and *d*, then we shall not get all the lines of *a*; we shall only get some of them, the longest lines; and if the quantity *a* is very small indeed, then we shall only get one line—the longest, in the spectrum of the vapour.

The method of mapping adopted may next be stated. In order to get as much light as we could out of the work, first of all the Fraunhofer lines were mapped in a manner which enabled anybody who took the trouble to look at the map to see which was darkest. In addition to those Fraunhofer lines information is given showing the origin of them.

I should tell you that it has been found since Kirchhoff's first researches that it does not do to talk about the spectrum of a substance as if it were an unchangeable thing. To be precise we must refer to the spectrum at the temperature of the arc; or at the temperature of the electric spark with a jar or without a jar; or at the temperature of the oxy-hydrogen flame. These spectra are very different indeed, not with regard so much perhaps to the actual lines which we see in any case, but chiefly with regard to the intensity of the lines as seen in one spectrum and in the other.

Thus it was useful to compare the lines of a substance as seen in the arc and spark with that seen in the spots, and that, so to speak, formed the ground-plan of the maps. The work to be done was to observe all the lines most widened in a region of the spectrum, and see whether they were absolutely unchangeable or whether they were not.

The diagram shows a part of one of these maps dealing with the first 100 observations. The Fraunhofer lines are at the top; the lengthening of the lines representing the intensity, that is to say, the longest line is the darkest. Below are the lines of the substance being specially studied seen in the electric arc, the longest being the brightest; and lower still the lines seen in the electric spark, the longest line also being the brightest.

We observe in the first place that there is a very considerable difference in these two spectra. We have a considerable number of lines seen in the arc, and seen in the solar spectrum among the Fraunhofer lines, which are not seen in the spectrum of the spark, the temperature of which of course is assumed to be very much higher than the temperature of the arc.

Again we may have a very faint line at the temperature of the arc, which is considerably intensified when we pass to the temperature of the spark. There are, again, other lines seen nearly of the same length both in the arc and in the spark.

Now, when we first mapped the spot observations, the maps did not indicate the origin of the lines, and when there was a great variation in the lines discovered it was a fair thing to say that the explanation lay in the fact that some of the lines belonged to one substance, and some to another. Let us call those two substances *a* and *b*. In some spots we have more of *a* and in other spots we have more of *b*. That of course was very good reasoning, so good that it was necessary to undertake a complete discussion in the case of each element. In this case the spot lines studied are not all the lines which were seen in spots, but the lines of one substance. Now the moment this work was begun strange results appeared, and the matter became difficult, because we should have imagined *a priori* that if the same substance were always present in the spot we should always have got the same spectrum, or, at all events, a spectrum along that line to which I have already referred, viz., that if the relative quantity of the vapour were less the number of its lines would be reduced, and at last when the quantity was the least possible the number of lines would be the least possible. I must call your attention to the fact that we found *inversions*, as they are now called; that is to say, to take an instance, if we represent three lines of a spectrum by *a*, *b*, and *c*, we have found among the most widened lines in spots *a* without *b* and *c*, *b* without *a* and *c*, and *c* without *a* and *b*. Now that is a condition of things impossible to understand or explain on the old view.

We next continued the discussion over another region of the spectrum, and we found that the result held absolutely good, that is to say, in other regions we got these same inversions. If we look at a map belonging to another period, although the lines change, the inversions remain, and the lines behave very much in the same way as the other. This result is quite constant for all regions of the spectrum examined. Hence, finally, we learn that these inversions hold good for different periods, and for different parts of the spectrum; and we have found that spectroscopically any one vapour in the spots behaved in exactly the same way as various mixtures of many vapours would be bound to do.

The result of this inquiry with regard to chemical substances which have been most carefully worked out, is indicated in the accompanying table, giving the result of the work for two years from 200 spots.

Statistics of the most Widened Lines seen in 200 *Sunspots at Kensington*

	Total number of lines in part of spectrum discussed	Total number of lines widened
Iron	172	72
Titanium	120	38
Nickel	24	9
Zinc	19	5
Cobalt	17	3
Calcium	17	7
Chromium	15	9
Molybdenum	14	1
Tungsten	14	2
Manganese	13	4
Platinum	12	1
Barium	10	1
Copper	10	1
Sodium	7	2

In these 200 spots out of 172 lines of iron which we might have seen only 72 were observed altogether; out of 120 lines of titanium which we might have seen only 38 were seen; and then the number goes on decreasing: 24 in the case of nickel, of which 9 were seen; 19 in the case of zinc, of which 5 were seen; 13 of magnesium, of which 4 were seen; 12 of platinum, of which 1 was seen, and so on.

The final upshot is, therefore, that at the spot-level we do not see the Fraunhofer spectrum, as we ought to do on the old theory. What we do see is a small percentage of the lines, and we see them under conditions which are entirely unexpected. No one, I think, who knew anything about spectrum analysis would have anticipated the result which we have got at Kensington in these 700 observations.

These, though the earlier results, are not the only results which we may hope to get by going on with the work. At present we have limited ourselves to recording the dates of the spots. But this is not enough; we must know the actual positions of the spots on the sun. We must note whether each particular spot is in the northern hemisphere or in the southern hemisphere, with the view of determining whether there is any chemical difference between the north part of the sun and the south part; and then again we shall have to compare the latitudes of spots, with the view of determining whether there is any difference in the chemistry of the spots according to the latitude. I may tell you that we are working at that particular point just now, and it really does look as if the sudden changes in the spectra recorded may have been due to the fact that the spots compared were spots varying very considerably in latitude, and it would not surprise me to find that spots which are very like each other in their spectra will be found to be situated more or less in the same degree of latitude,—whether the same degree of latitude north or south we do not know. And there is another question, too. I pointed out that there is a considerable number of lines seen in the spectrum of the arc which are left out of the spectrum of the spark. Now, will that help us at all in our inquiries? I think perhaps it may. Everybody assumes that the electric spark is hotter than the electric arc. If that be so, the lines which we see at the temperature of the arc, and which we do not see at the temperature of the arc only, may represent the lines due to cooler vapours—more complex molecular groupings it may be, which can exist in the cooler temperature, but which entirely break up on the application of a higher one. If that be so we shall be able to sort out the spots more or less according to their temperature.

Though the results have not been shown on the maps, the lines visible in the spectrum of some substances at the temperature of the oxy-hydrogen jet have been observed. Everybody assumes that the temperature of the oxy-hydrogen jet is lower than the temperature of the electric arc or spark; so that, if we can get a spot which gives us those lines thickened only which we see at the temperature of the oxy-hydrogen jet, we should be perfectly justified, I think, in saying that that was a relatively cool spot; whereas, if we saw a spot which only had those lines thickened which are intensified on the passage from the temperature of the arc to the temperature of the spark, we should be justified in saying that that spot was very much hotter. I only throw this out as an indication of the kind of result which probably future working and future thought will bring out, and that we are by no means at the end of the work yet.

J. NORMAN LOCKYER

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The new Medical Statute was finally approved by Convocation on March 16. The scope of the new Statute and its bearing on the study of medicine at Oxford were so clearly described by Prof. Burdon-Sanderson in last week's NATURE, that it is unnecessary to refer further to them. One point insisted on by the Professor, that the present student of medicine wastes his first year over Pass Moderations, has not yet been corrected. The Moderations Committee are still deliberating, but there seems little doubt that students of Natural Science in Oxford will receive substantial relief under the new scheme.

The present year is one of reform. While the Moderations question is still under debate, a new and much-needed reform has been sprung upon the University. The old Examination in the Rudiments of Faith and Religion has by common assent become out of date. Last week the preamble of a new Statute was passed *nemine contradicente* in Congregation. We must wait till next term to learn the fate of the Statute itself. It seems time that the University should grant degrees without demanding an intimate knowledge of the Thirty-nine Articles.

CAMBRIDGE.—It has been decided to establish a Tripos Examination in Engineering, to be combined with the present Natural Sciences Tripos. The general basis is that, as an alternative to the present First Part of the Tripos, an examination in certain mathematical subjects useful in engineering, physics, chemistry, and theory of structures shall be held, to be followed by a practical examination. Those who pass this will be entitled to a degree in honours. A later examination, concurrent with the second part of the Natural Sciences Tripos, is to consist of advanced papers in Physics, Chemistry, and Engineering, distinction in one or more of which is to entitle a student to a first class. When the complete scheme is published we shall give full details.

SCIENTIFIC SERIALS

The Journal of Physiology for November 1885, vol. vi. No. 6, contains:—On a double differential rheotome, by Dr. W. D. Samways (plate 7). The instrument is described and figured.—On the blood of Decapod Crustacea, by Dr. W. D. Haliburton (plate 8). Assisted in part by a grant from the British Medical Association, the author has studied the blood in the lobster, the edible crab, the crayfish, Astacus, and *Nephrops norvegicus*; and he treats of its colour, constituents, and coagulation. He ascribes the clot as due to the formation of a body scarcely to be distinguished from the fibrin of vertebrate blood, and believes that its formation is due to a ferment action, which latter is derived from the amœboid corpuscles of the blood. At the close of the memoir the author treats of the comparative aspects of crustacean blood, and gives a table of the invertebrates in which hæmocyanin and hæmoglobin have been found.—On the nature of papain and its action on vegetable proteid, by Dr. Sidney H. C. Martin. The proteids present in papain are globulin and albumin, and two forms of albumose. No peptones were found.—Regarding the influence of the organic constituents of the blood on the contractility of the ventricle, by Dr. Sydney Ringer (plate 9). He infers that the arrest of contractility with a saline solution is not due to the removal of pabulum to support the contractions, but that lime and potassium salts are necessary ingredients in a circulating fluid to supply the conditions essential to the change occurring during a contraction, there being stored up in the muscular tissue a material to carry on contractions which cannot be washed out by a fluid circulating in the heart cavities.—On the nature of glomerular activity in the kidney, by J. G. Adami. It would seem that the glomerular epithelium has properties of a definite secretory nature; they may even be regarded as (in the dog) having powers of a selective secretory nature.—Plethysmographic and vaso-motor experiments with frogs, by Dr. Fred. W. Ellis (plates 10 and 11).—On some vaso-motor functions of the spinal nerves in the frog, by W. Horscraft Waters.

The Journal of Anatomy and Physiology for January 1886, vol. xx. part 2, contains:—Prof. Macalister, morphology of the arterial system in man, part i.—R. Austin Freeman, the anatomy of the shoulder and upper arm of the mole (plate 5).—Dr. Hans Gadow, on the reproduction of the carapax in tortoises (plate 6). In the case experimented on, the dermal armour was cast off, after injury, down to the soft cutaneous layers; the bulk of these produced cutis, which then underwent the normal process of ossification, until at last a new complete armour was formed. The author cites, as an analogous case, "the reproduction of bark from the *whole surface of the cambium* laid open after the destruction of the old cortex." Is this so?—Dr. A. M'Aldowie, on the development and decay of the pigment-layer in birds' eggs.—Dr. D. J. Cunningham, the connection of the os odontoideum with the body of the axis.—Dr. R. W. Shufeldt, on the skeleton of Geococcyx (plates 7-9); a very full account of the skeleton of this rare bird.—Dr. Noël-Paton, relationship of urea-formation to bile-secretion; part ii. of these important experimental researches. The formation of urea in the liver bears a very direct relationship to the secretion of bile by that organ.—Dr. W. Hunter, recent histological methods.—Prof. W. Turner, the sacral index in various races of mankind; makes two classes—where the sacral index is below 100 (Dolichohieric), and where it is above 100 (Platyhieric).—Dr. J. L. Gibson, the blood-forming organs and blood-formation, part ii.

Zeitschrift für wissenschaftliche Zoologie, Band xliii. Heft 1 (Leipzig, December 31, 1885), contains:—Prof. A. Kölliker, histological studies of Batrachian larvæ (plates 1 and 2). Almost forty years ago Prof. Kölliker published his first account of the development of the Batrachian tissues, but the improvement in methods of research and the expansion of knowledge as to nerve-bundles and other endings have caused him to alter his opinions on several matters, and in this memoir we find his latest views on the structure, development, and terminations of the nerves; also some general considerations of the structure of the nerve-fibre and on the development of the blood- and lymph-vessels.—W. Schwarze, on the post-embryonal development in Trematodes (plate 3). These researches were made on *Cercaria armata* and *C. echinata* from *Limneus stagnalis*, and on *C. ornata* and *C. spinifera* from *Planorbis corneus*. A useful bibliography of the literature is appended.—Hermann Uhde, on the dorsal pore of the terrestrial Oligochæts: a contribution to the histology and classification of the Lumbricidæ (plate 4). In this memoir, in addition to a very detailed list of the literature of the subject and to a chapter on anatomical details, we have an account of the various species, based on materials collected from various parts of the world.—Dr. Deichler, on Protozoa parasitic in the sputa of whooping-cough.—Dr. E. Witlaczil, on the morphology and anatomy of the Coccidæ (plate 5).

Morphologisches Jahrbuch (*Gegenbaur's*), Band xi. Heft 3 (Leipzig, 1885), contains:—Dr. Béla Haller, researches on the marine Rhipidoglossa (plates 17-24), part ii. The first part of Haller's researches appeared in vol. ix. The present part treats of the structure of the central nervous systems and their envelopes. The material operated on was obtained at Trieste from Fissurella, Haliotis, and Turbo, and the conclusion is arrived at that without doubt the nerves throughout this group of Mollusca have a double origin.—Dr. H. Virchow, on the form of the plicæ of the ciliary body in mammals (plate 25). These folds, so comparatively small in the human eye, are largely developed in the rabbit.—Dr. W. Pfitzner, on the division of the nucleus in Protozoa (plate 26). These observations were chiefly on the nuclei in *Opalina ranarum*, and show the general similarity of the kariokinesis in this Protozoon with that in Metazoa.—Dr. G. Baur, notes on the "astragalus" and the "intermedium tarsi" in mammals (plate 27). As introductory to these notes a very copious account of the literature of the subject is given.—Among the short notices are: on the nerve-canal in the humerus of the Amniota, by Prof. U. Fürbinger; and on the rudiment of a septal nasal gland in man, by Prof. Gegenbaur.

Rendiconti del Reale Istituto Lombardo, January 21.—On the grape-vine mildew; observations and remedies, by Prof. Gaetano Cantoni. Although usually supposed to have been for the first time introduced into Europe from America about 1877, the writer quotes a correspondent in the *Bulletin* of the French Agricultural Society, who states that this disease was known in Alsace under the name of *mildau* over forty years ago. From Alsace it passed to America, where the name became Anglicised, recently returning to Europe under the designation of grape-vine mildew. The best prophylactic remedies hitherto discovered are the sulphate of copper and milk of lime, applied either separately or in combination about the beginning of June, and repeated, if necessary, towards the end of August or beginning of September.—On the formation of dew, by Prof. Giovanni Cantoni. It is shown that the theory recently communicated by Prof. Aitken to the Edinburgh Royal Society and described in NATURE for Jan. 14 (p. 256), agrees with the conclusions already arrived at by Fusinieri, Melloni, and other Italian meteorologists.—Summary of the meteorological observations made at the Brera Observatory, Milan, during the year 1885, prepared by E. Pini.

Mittheilungen der Naturforschenden Gesellschaft in Bern, Nos. 1092-1132 (1884-85).—Wind and precipitates in Bern (from records of Bern Observatory during fifteen years), by Herr Benteli.—On a case of rapid hole-formation in rock, by Herr Baltzer.—On lake-balls, by Herr Coaz.—On the theory of trisection of angles, by Herr Moser.—On the termination of nerves in striped muscles of man, by Herr Flesck.—On a case of loess in Canton Bern, by Herr Baltzer.—On the oldest map of Switzerland of Ægidius Tschudi, by Herr Graf.—Mathematical researches on the colour of thin gypsum plates in polarised light, by M. Jonquière.—On the poisoning with *Amanita phalloides* in Bern in 1884, by Herr Studer, jun.—On the occurrence of the vascular wave in the carotid-curve, by Herr Mützenberg.—Contributions to a comparison of the brain-fissures in Carnivora and Primates, after examination of a lion's brain, by Herr Familiant.—On the chemistry of food-stuffs, by Herr Fueter-Schnell.—On a new occurrence of rock-crystal in Switzerland, by Herr von Fellenberg.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft in Lucerne, September 1884.—We note here the President's (Herr Suidter-Langenstein) opening address, dealing with the Lucerne region in geological, meteorological, and biological aspects; also two interesting reports on prize competitions—one relating to a climatology of Switzerland, the other to the deep-water fauna of Swiss lakes.

Journal de Physique, February.—On refrigerating mixtures and the principle of maximum work, by M. Potier.—On the critical temperatures and the pressures of some gases, by MM. Vincent and Chappuis.—Researches on the freezing temperature of solutions, by M. Raoult.—On the formula of plane gratings, by M. Branly.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 10, 1885.—"On the Magnetisation of Steel, Cast Iron, and Soft Iron." By John W. Gemmell.

In this paper the author describes and gives the results of a series of experiments upon particular specimens of iron and of steel. The specimens consisted of wires of "soft Scotch iron," "common wire," "charcoal iron," and "soft steel," with bars of cast iron and malleable iron; and the object of the investigation was to find the difference between these, with respect to the intensities of their total and residual magnetisation, due to different degrees of magnetising force.

The apparatus was arranged, and the experiments made, according to a simple magnetometric method fully detailed in the paper. The magnetising currents were derived from a battery of Thomson's tray Daniells, so arranged that any number of cells could readily be placed in the circuit.

The results represent the effect of a current gradually increased from 0 to the maximum, gradually diminished to 0 again, and of the same process repeated with a negative current. They are shown in curves, the abscissæ of which are proportional to the magnetising forces, and the ordinates to the magnetisation produced. Figures are given by which to reduce these values to absolute measure.

It has been found that the "charcoal iron" has the highest magnetisability, and the "soft steel" the lowest; while that of the "soft Scotch iron" approaches the former. With regard to retentiveness, the "charcoal iron" shows the least, and the "soft steel" the greatest. Annealing the latter, however, has the effect of bringing it very near the "common wire," both in respect of magnetisability and retentiveness. The two specimens of cast iron differ considerably. The malleable iron bar shows a very much higher magnetisability than the cast iron ones, and its residual magnetisation was so low that it could not be observed with the same arrangement of apparatus.

These curves also present certain anomalies which are worth investigation. The space about the zero on an enlarged scale is affixed to each set to show its peculiarities more clearly.

In the curves representing the residual magnetisation we find a loop between the direct and return curves, more or less marked in all the diagrams. A similar feature presents itself in the curves of total magnetisation in two of the diagrams, and there seems to be a tendency always to form this loop.

In that part of the return curve which represents the effects of the small magnetising forces, the residual magnetism is seen first to take a greater value, and then to diminish again just before the zero of magnetising force is reached. This may be observed also in the negative return curve.

January 21.—"On Radiant Matter Spectroscopy: Note on the Spectra of Erbia." By William Crookes, F.R.S.

I have recently succeeded in getting the earth erbia in a sufficiently pure state to allow me to examine its phosphorescent spectrum without the interference which might be produced by the presence of yttria, samaria, holmia, thulia, Yα, or ytterbia. As in the case of yttria,[1] the spectrum is best seen when erbic sulphate is heated to redness and submitted to the electric discharge in a high vacuum. The addition of calcic sulphate interferes with the purity of the spectrum. In this respect erbia differs from samaria, as the latter earth seems to require the presence of some other metal to develop its phophorescent properties.

The phosphorescent spectrum of erbia consists of four green bands, of which the following measurements have been taken:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
9·750	5564	3230	Approximate centre of a wide band, shading off at each side.
9·650	5450	3367	Approximate centre of a band, narrower and somewhat fainter than the first band.
9·525	5318	3536	Approximate centre of a narrow band, bright and moderately sharp on each side.
9·400	5197	3702	Approximate centre of a band, similar in appearance to the first band, but brighter.

These bands do not correspond in position to any in either the yttrium or samarium spectrum. The nearest approach to a coincidence is between the first erbia green and the samarium green, but when the two spectra are examined one over the other it is seen that the samarium band is less refrangible than the erbium band.

[1] *Phil. Trans.*, part iii., 1883, p. 913 (par. 71).

The first green of Yα occurs midway between the first and second greens of erbia, and the second Yα green comes between the second and third erbia greens.

Pure erbia is of a beautiful rose-pink colour. When illuminated by sun or electric light and examined in the spectroscope it gives a spectrum of black lines and bands as sharp and distinct as the Fraunhofer lines. It is strange that this most characteristic property has been recorded by so few observers. Indeed, the only notice of it I have come across is a passing remark of Prof. Clève's that "the light reflected by dry erbia shows absorption bands."

The absorption spectrum given by a solution of pure erbic chloride differs in some respects from the drawings mapped from older observations, as the absorption lines of holmia and thulia are absent. The fine group of lines in the green of the reflection spectrum is also absent in the absorption spectrum.

The spectrum of bright lines emitted when erbia is rendered incandescent in the blow-pipe flame has been often observed, but the lines in this case are luminous on a fainter continuous background, and are not particularly sharp, whilst the reflection spectrum consists of black lines sharply defined on a continuous spectrum.

February 4.—"A Further Inquiry into a Special Colour-Relation between the Larva of *Smerinthus ocellatus* and its Food-plants." By Edward B. Poulton, M.A., of Jesus and Keble Colleges, Oxford. Communicated by Prof. J. S. Burdon-Sanderson, F.R.S.

The object of the paper was to give an account of the investigation upon this subject which had been undertaken in 1885, having been continued from the previous year (described in *Proc. Roy. Soc.*, No. 237, 1885, p. 269). The points which had been raised, and upon which evidence was desired, were as follows:—(1) The larvæ are generally uniformly coloured on the same food-plant, but sometimes there are exceptions; can any of these be due to the hereditary transmission of the influence of food-plants upon the parent larvæ? (2) Is the colour of the larva influenced by the colour of the environment which, acting upon some sensory surface, directs the kinds and amounts of pigments deposited, or absorbed from the food? (3) It was also important to test the effects of certain new food-plants and of others about which the evidence was conflicting; and (4) to look out for any indications which would throw light upon the red-spotted varieties, or upon the existence of individual variation of any kind, under similar conditions of parentage and food; and (5) to inquire into the periods during which the larvæ are most susceptible to the colour-influence.

Experiments in 1885.—These were divided into five series, as the larvæ came from five batches of eggs. The differences between the larvæ are expressed in five degrees: white, whitish-intermediate, intermediate, yellowish intermediate, and yellow. *Series I.* Eggs were laid by a moth bred from a larva which had been a typical whitish variety (as was also the case with the male parent). The resulting larvæ were whitish (5) upon *Pyrus Malus* (var. *acerba*), intermediate (1) upon *Populus tremula* and another species of poplar, intermediate (1) upon *Salix babylonica*, and whitish (2), although they did not become adult, upon *S. rubra* and other similar species of sallow. In this series the hereditary influence on the side of white is seen to be strongly marked on comparing the effects with those shown in the other series and in the parent larvæ (see former paper). *Series II.* Eggs were laid by a moth bred from a whitish-intermediate larva, without any act of coitus having been witnessed (although male moths were present). Most of the eggs shrivelled up, but a few hatched, and form the larvæ of this series. Subsequently coitus was induced (artificially), and a large number of fertile eggs were laid which are considered under the next series. The larvæ of Series II. were whitish (4) upon *Salix viminalis*, although not to such an extent as upon apple, and yellowish-intermediate (1) upon *S. Smithiana* and another sallow with similar leaves. These results are rather irregular, for the former larvæ were whiter than the parents, the latter yellower than it is probable that the parents would have been on the same tree. But the results were not unusual in themselves. *Series III.* The female parent was the same as in Series II.; the male parent was bred from a typical whitish larva. The resulting larvæ were whitish (6) upon ordinary apple, and upon the same with the leaves sewn to expose the under sides (1), and to expose the upper sides (3) (none of these reached maturity, and the last lot were especially young when they died); whitish (4) but immature upon crab (var. *acerba*); whitish-intermediate

(5) upon *Salix viminalis;* white (1) but immature upon *S. viminalis*, sewn to show the under sides; yellowish-intermediate (2) but immature upon *S. alba;* whitish-intermediate (4) but mostly immature upon *S. Smithiana* and similar leaves; intermediate (1), yellowish-intermediate (5), and yellow with traces of the red spots (1) upon *S. cinerea;* intermediate (1) upon *Populus nigra;* intermediate (6) and yellowish-intermediate (2) upon *S. triandra;* yellowish-intermediate (10) upon *S. triandra* without the bloom on the under sides of the leaves; yellowish-intermediate (4) upon *S. babylonica* (when the larvæ were young and more numerous, one of them in the fourth stage possessed traces of the upper row of rust-coloured spots, and was a whitish variety: it was put upon apple and died as an intermediate variety when advanced in the last stage); intermediate (1) and yellowish-intermediate (3) upon *S. rubra*. The results of these experiments were mostly what might have been anticipated from the colour of the leaves. The especially interesting results were: the effects produced by the sewn leaves of *S. viminalis* and the bloomless leaves of *S. triandra* as compared with the normal leaves in both cases, and the occurrence of red spots on two larvæ—one, the only yellow variety obtained, and the other an intermediate variety. The indications of individual variation in the *S. cinerea* larvæ were also interesting. *Series IV.* All these larvæ died before trustworthy observations could be made; they had been reserved for experiment: the ocelli of many were covered with a harmless opaque layer (lamp-black and McGuilp) in the attempt to isolate the sensory surface which is affected by the colour of the environment. Others were fed upon apple and *S. rubra*, and a certain number were changed at every stage, so as to find the periods during which the larvæ are most susceptible to the surrounding colour. The failure of all these was due to the season and not the conditions of the experiment. *Series V.* The female parent was bred from a yellowish-intermediate larva, the male parent from a yellow larva. The resulting larvæ were, intermediate (1) upon *S. viminalis* sewn to show the upper sides of the leaves; intermediate (1) and yellowish-intermediate (1) upon *S. cinerea*. The first result was interesting, but the second shows that the larvæ did not tend much towards yellow. The hereditary influence towards yellow in this case depends chiefly on the male parent, and how far this element asserts itself in opposition to the other sex is quite unknown in this class of experiment.

Results of the Experiments.—The existence of hereditary influence is, on the whole, demonstrated. The parent larvæ tended towards white, and out of the 75 larvæ of the next generation, there was only one yellow variety. Yet the latter were, on the whole, rather more influenced in the direction of yellow than the parents, when the plants tended this way. The results were the same as in the parents when very powerful white influence was used (apple, &c.) The comparison of the different series was less satisfactory, but the hereditary differences were mostly delicate, except between V. and the other series.

Series I. and III. compare favourably, while in II. the parentage is very obscure. There is conclusive proof that it is the colour of the leaf, and not its substance when eaten which influences the larval colours.

Conflicting evidence as to the effect of plants is cleared up. *S. triandra* produces yellow; and Mr. Boscher's white larvæ, said to have been found upon this plant, occurred upon the very similar, but much whiter, *S. alba*. Previous conclusions as to *S. Smithiana* and *S. babylonica* are confirmed. The existence of individual variation with similarity of parentage and conditions is now proved, although it is rare and slight (8 out of 75 in 1885, 0 out of 23 in 1884). Thus it cannot explain the extreme differences met with in the field (1884), *e.g.* yellow upon apple, &c. The colours of the larvæ are determined by (1) the food-plant; (2) hereditary influence; (3) individual variation. Slight differences may be caused by the latter; extreme differences by the two former. The uncertain action of (1) will be shown later. The two red-spotted larvæ were very interesting, showing how the character tends to appear on the yellow varieties (the only yellow one produced), and yet that it may appear upon the other varieties (which is a new experience).

Observations in the Field in 1885.—(1) White variety upon ordinary apple; (2) white and (1) intermediate upon *S. viminalis;* (1) yellowish-intermediate upon *S. linearis* (Forbes); (1) yellow upon *S. incana* in Switzerland; (1) white upon *S. alba* (ordinary) in Switzerland; (1) yellowish-intermediate upon var. *S. alba* (? *vitellina*) in Switzerland; (2) yellow upon var. *S. alba* in Switzerland; (1) whitish-intermediate upon *S. Smithiana*; (4) yellow and (1) whitish-intermediate upon *S. cinerea;* (4) yellow upon *S. triandra;* (1) yellowish-intermediate upon *S. babylonica;* (12) yellow and (3) yellowish-intermediate upon *S. rubra*. All, except the five in Switzerland, were found at Oxford.

Conclusions from Captured Larvæ; Reconciliation of Conflicting Evidence.—The results recorded above were very uniform. Only in the case of *S. cinerea* was there any great difference between the larvæ on the same tree, for the Swiss varieties of *S. alba*, which produced yellowish larvæ, had leaves resembling *S. rubra* rather than the ordinary English *S. alba*, with one exception (which produced the white larva). At the same time there were two instances which perplexed me for a long time, and finally suggested the explanation which clears up the greatest difficulty in the way of the theory—the conflicting evidence (Mr. Boscher's and my own) with regard to the action of *S. viminalis*. These instances were, the yellowish intermediate larva upon *S. linearis* and the yellow one upon *S. incana*. Both the trees had small narrow leaves with very white under sides, and yet the larvæ were not white. *S. linearis* is whiter than apple or any sallow that I have seen. Then I remembered that the single yellow larva I had found upon *S. viminalis* (in 1884) was upon a tree with very small leaves; finally, I had the opportunity of looking at twigs from the trees upon which Mr. Boscher had found about eighteen yellow larvæ. These, too, bore very small leaves, although they were as white as usual on the under sides. This association of yellow larvæ with small leaves (although white) suggested the following explanation. It is the *immediate* environment almost in contact with the larva which has the greatest effect upon it, and the longer it acts the more extreme will be the result. The larvæ habitually rest upon the under sides of the leaves, until their size and weight render it impossible for them to do so longer; then they retire to the stem. Hence the larvæ rest for a much longer period of their lives upon large and strong leaves than upon small ones, and therefore, in the former case, the effect of the white under sides is much more powerful, for after the larva has reached the stem the immediate environment is less exclusively white, and may be largely formed by the green or yellowish upper sides of the leaves (depending upon the arrangement of the latter). This completely explains the conflicting results upon *S. viminalis*, for there is an immense difference in size between the leaves of the two forms upon which the two varieties of larva have been found; and the arrangement is also different, tending to produce a white environment after the larva has gone to the stem in the case of the large-leaved trees, but not in the small-leaved forms. This explanation is valid for other food-plants in exact proportion to the difference in colour between the two sides of their leaves. Thus it is probable that it explains in a great measure the yellow effect of the small-leaved *S. cinerea*, and the much whiter effect of the large-leaved *S. Smithiana;* both having very similar leaves with white under sides. It also explains the very powerful effect of apple, with its large strong leaves, which are arranged so as to give a maximum white effect after the larva has retired, very late in life, to the stem. Another difficulty is also cleared up by this suggestion—the fact that bred larvæ in 1884 and 1885 became intermediate upon large-leaved *S. viminalis*, although they tended towards white (as shown by the effect of other plants). The long leaves were disarranged when crowded into the glass cylinders in which the larvæ were kept, and so the immediate environment of the larvæ was artificially altered when they were on the under sides of the leaves, and also on the stem. Furthermore, they were often disturbed by changing the food, and so did not rest upon the white surfaces for such long periods as in the natural state. The larvæ found in the field upon *S. rubra* and plants tending towards yellow were much more extreme varieties than those produced by breeding. This is partly due to the hereditary influence towards white in the latter case, but also probably to the white muslin which was tied over the breeding cylinders, and to the less amount of direct sunlight obtainable indoors and among the crowded leaves. In the field the larvæ habitually rest on the most exposed and tallest boughs, of which the colours are most brightened by sunlight, and such an environment therefore produces a very strong influence upon them. Such considerations suggest that it will be very interesting to breed the larvæ under coloured light, and I intend to make the experiment this summer.

Conclusion.—The whole evidence for the theory of colour-relation advanced in the present paper consists of 204 instances, of which about half were bred and the rest found in the field. Such is the evidence for the conclusion that the larva of *Smerinthus ocellatus* maintains a colour-relation with the food-plant upon which it was hatched, adjustable within the limits of a single life, and that the predominant colour of the food-plant itself is the stimulus which calls up a corresponding larval colour. This is an entirely new resource in the various schemes of larval protection by resemblance to the environment, and one which stands on a very different level from all others. In the latter the gradual working of natural selection has finally produced a resemblance, either general or special, to something which is common to all the food-plants of the larva or to some one or more of them, the larva being less protected upon the remainder. But in the former case the same gradual process has finally given the larva a power which is (relatively) immediate in its action, and enables the organism itself to answer with corresponding colours the differences which obtain between its food-plants. This action is very different from the much more rapid changes of colour in other organisms (amphibia, fish, &c.), for in them the changing colours of the environment act as stimuli, which, through a nervous circle, modify the condition of existing pigments; while in the larva the influence makes itself felt in the absorption and production of pigments rather than their modification when formed; and such a method of gaining protection is, as far as we yet know, unique in the animal kingdom. And the power is not confined to the species in which its existence has been to some extent completely proved. There are already proofs that many other larvæ can maintain a similar colour-relation, and careful observation will doubtless reveal many slight and protective differences among larvæ of the same species when found upon differently-coloured food-plants, and will prove that this power is not at all uncommon among the great body of lepidopterous larvæ which adopt the methods of protective resemblance.

February 11.—"On the Theory of Lubrication and its Application to Mr. Beauchamp Tower's Experiments, including an Experimental Determination of the Viscosity of Olive Oil." By Prof. Osborne Reynolds, LL.D., F.R.S.

The application of the hydrodynamical equations for viscous fluids to circumstances similar to those of a journal and a brass in an oil-bath, in so far as they are known, at once led to an equation [1] between the variation of pressure over the surface and the velocity, which appeared to explain the existence of the film of oil at high pressure.

This equation was mentioned in a paper read before Section A at the British Association, at Montreal. It also appeared from a paragraph in the Presidential Address (p. 14, B.A. *Report*, 1884) that Prof. Stokes and Lord Rayleigh had simultaneously arrived at similar results. At that time the author had no idea of attempting the integration of this equation. On subsequent consideration, however, it appeared that the equation might be so transformed [2] as to be approximately integrated by considering certain quantities small, and the theoretical results thus definitely compared with the experimental.

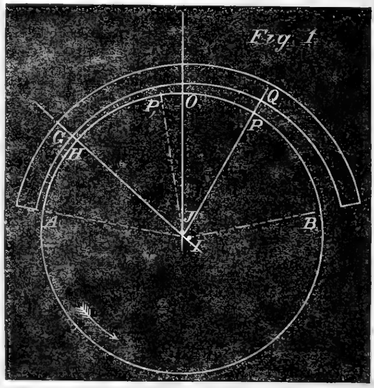
The result of this comparison was to show that with a particular journal and brass the mean thickness of the film would be sensibly constant for all but extreme values of load divided by viscosity, and hence if the coefficient of viscosity were constant the resistance would increase approximately as the speed.

As this was not in accordance with Mr. Tower's experiments, in which the resistance increased at a much slower rate, it appeared that either the boundary actions became sensible, or that there must be a rise in the temperature of the oil which had escaped the thermometer used to measure the temperature of the journal.

That there would be some excess of temperature in the oil film on which all the work of overcoming friction is spent is certain, and after carefully considering the means of escape of this heat, it appeared probable that there would be a difference of several degrees between the oil-bath and the film of oil.

This increase of temperature would be attended with a diminution of viscosity, so that as the resistance and temperature increased with the velocity there would be a diminution of viscosity, which would cause the increase of the resistance with the velocity to be less than the simple ratio.

In order to obtain a quantitative estimate of these secondary effects, it was necessary to know the exact relation between



the viscosity of the oil and the temperature. For this purpose an experimental determination was made of the viscosity of olive oil at different temperatures as compared with the known viscosity of water. From the result of these experiments an

No. of equation in the paper

[1] $$\frac{dp}{dx} = \frac{6\mu U\,(h - h_1)}{h^3} \quad . \; . \; . \; . \; . \; (31)$$

in which p is the intensity of pressure, μ coefficient of viscosity, x the direction of motion, h the interval between the journal and the brass, h_1 being the value of h for which the pressure is a maximum, U the surface velocity in the direction of x.

[2] If the journal and brass are both of circular section, as in Fig. 1, and R is the radius of the journal, R + a radius of brass, J the centre of the journal, I the centre of the brass, JI = ca, HG the shortest distance across the film, IO the line of loads through the middle of the brass, A the extremity of the brass on the off side, B on the on side, P_1 the point of greatest pressure

putting
$$\text{OIH} = \phi_0 - \frac{\pi}{2}$$
$$\text{OIP}_1 = \phi_1$$
$$\text{OIP} = \theta$$
$$h = a\{1 + c\sin(\theta - \phi_0)\}$$
$$h_1 = a\{1 + c\sin(\phi_1 - \phi_0)\}$$

the equation (31) becomes

$$\frac{dp}{d\theta} = \frac{6R\mu c\{\sin(\theta - \phi_0) - \sin(\phi_1 - \phi_0)\}}{a^2\{1 + c\sin(\theta - \phi_0)\}^3} \quad . \; . \; (48)$$

if $\frac{a}{R}$ is small. This equation, which is at once integrable when c is small, has been integrated by approximation when c is as large as 0·5.

The friction is given by an equation

$$f = -\tfrac{1}{2}R\frac{d\theta}{dp}a\{c\sin(\theta - \phi_0)\} - \mu\frac{U_1 - U_0}{a\{1 + c\sin\theta - \phi_0\}} \quad . \; . \; (49)$$

This is also approximately integrated up to $c = 0{\cdot}5$.

ϕ_0 and ϕ_1 and c have to be determined from the conditions of equilibrium, which are

$$\int_{-\theta_1}^{\theta_1}\{p\sin\theta - f\cos\theta\}dp = 0 \quad . \; . \; . \; . \; (44)$$

$$\int_{-\theta_1}^{\theta}\{p\cos\theta + f\sin\theta\}d\theta = \frac{L}{R} \quad . \; . \; . \; . \; (45)$$

$$\int_{-\theta}^{\theta} f d\theta = \frac{M}{R^2} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (46)$$

where $2\theta_1$ is the angle subtended by the brass, L the load, and M the moment of friction.

The solution of these equations may be accomplished when c is small, and has been approximately accomplished for particular values of c up to 0·5, the boundary conditions as regards p being

$$\theta = \pm\,\theta_1 \qquad p = p_0,$$

whence substituting the values of ϕ_1, ϕ_0, c in (48) and (49), and integrating, the values of the friction and values of the pressure are obtained.

empirical formula has been deduced for the viscosity of olive oil at all temperatures between 60° and 120° F.[1]

Besides the effect on μ the temperature might, owing to the different expansion of brass and iron, produce a sensible effect on the small difference a in the radii of the brass and journal, *i.e.* on the mean thickness of the film. E was taken for the coefficient of this effect, and since, owing to the elasticity of the material, the radius would probably alter slightly with the load, m was taken as a coefficient for this effect, whence a is given by an equation[2] in terms of a_0, its value with no load and a temperature zero.

Substituting these values in the equations, the values of the pressure and friction deduced from the equations are functions of the temperature, which may be then assumed, so as to bring the calculated results into accord with the experimental.

There was, however, another method of arriving, if not at the actual temperatures, at a law connecting them with the frictions, loads, and velocities. For the rise in temperature was caused by the work spent in overcoming friction, while the heat thus generated had to be carried or conducted away from the oil film. Consideration of this work and the means of escape gave another equation between the rise of temperature, the friction, and velocity.[3]

The values of the constants in this equation can only be roughly surmised from these experiments, without determining them by substituting the experimental values of f, U, and T, as previously determined, but it was then found that the experiments with the lower loads gave remarkably consistent values for A, B, E, m, and a_0, which was also treated as arbitrary. In proceeding to the higher loads for which the values of c were greater, the agreement between the calculated and experimental results was not so close, and the divergence increased as c increased. On careful examination, however, it appeared that this discordance would be removed if the experimental frictions were all reduced 20 per cent. This implied that 20 per cent. of the actual friction arose from sources which did not affect the pressure of the film of oil; such a source would be the friction of the ends of the brass against flanges on the shaft commonly used to keep the brass in its place, or by any irregularity in the longitudinal section of the journal or brass. A coefficient, n, has therefore been introduced into the theory, which includes both the effect of necking and of irregularity in longitudinal section. Giving n the value 1·25, the calculated results came into accordance with all Mr. Tower's results for olive oil, the difference being such as might well be attributed to experimental inaccuracy, and this both as regards the frictions measured with one brass, No. 1, and the distribution of the pressure round the journal with another, No. 2.

Not only does the theory thus afford an explanation of the very novel phenomena of the pressure in the oil film, but it also shows, what does not appear in the experiments, how the various circumstances under which the experiments have been made affect the results.

Two circumstances in particular which are brought out as principal circumstances by the theory seem to have hitherto entirely escaped notice, even that of Mr. Tower.

One of these is a, the difference in the radii of the journal and of the brass or bearing. It is well known that the fitting between the journal and its bearing produces a great effect on the carrying power of the journal, but this fitting is supposed to be rather a matter of smoothness of surface than a degree of difference in radii. The radius of the bearing must always be as much larger than that of the journal as is necessary to secure an easy fit, but more than this does not seem to have been suggested.

It now appears from this theory that if viscosity were constant the friction would be inversely proportional to the difference in the radii of the bearing and journal, and this although the arc of contact is less than the semi-circumference; and taking temperature into account it appears from the comparison of the theoretical frictions with the experiment on brass No. 1 that the difference in the radii at 70° F. was

$$a = 0{\cdot}00077 \text{ (inch)},$$

and comparing the theoretical pressures with those measured with brass No. 2,

$$a = 0{\cdot}00084 \text{ (inch)},$$

or the difference was 9 per cent. greater in the case of brass No. 2.

Another circumstance brought out by this theory, and remarked on both by Lord Rayleigh and the author at Montreal, but not before suspected is, that the point of nearest approach of the journal to the brass is not by any means in the line of load, and, what is still more contrary to common supposition, it is on the *off*[1] side of this line.

This point H moves as the ratio of load to velocity increases; when this ratio is zero, the point H coincides with O, then as the load increases it moves away to the left, till it reaches a maximum distance $\frac{\pi}{2} = \phi_0$, being nearly $-\frac{\pi}{2}$. The load is still small, smaller than anything in Mr. Tower's experiments, even with the highest velocities. For further increase of load, H returns towards O, or $\frac{\pi}{2} - \phi_0$ increases. With the largest loads and smallest velocities to which the theory has been applied this angle is about 40°. With a fairly loaded journal well lubricated it would thus seem that the point of nearest approach of brass to journal, *i.e.* the centre of wear, would be about the middle of the off side of the brass.

This circumstance, the reason of which is rendered perfectly clear by the conditions of equilibrium, at once explains a singular phenomenon, incidentally pointed out by Mr. Tower, viz. that the journal having been run in one direction for some time, and carrying its load without heating, on being reversed began to heat again, and this after many repetitions always heating on reversal, although eventually this tendency nearly disappeared. Mr. Tower's suggested explanation appears to the author as too hypothetical to be satisfactory, even in default of any other; and particularly as this is an effect which would necessarily follow in accordance with the theory, so long as there is wear. For the centre of wear, being on the *off* side of the line of loads, this wear will tend to preserve or diminish the radius of the brass on the *off* side, and enlarge it on the *on* side, a change which will, if anything, improve the condition for producing oil pressure while running in this direction, but which will damage the condition on which the production of pressure in the film depends when the journal is reversed and the late *off* side becomes the new *on* side. That with a well-worn surface there should be sufficient wear to produce this result with such slight amounts of using as those in Mr. Tower's experiments before reversal seems doubtful, but supposing the brass new and the surface more or less unequal, the wear for some time would be considerable, even after the initial tendency to heat had disappeared. Hence it is not surprising that the effect should have eventually seemed to disappear.

The circumstances which determine the greatest load which a bearing will carry with complete lubrication, *i.e.* with the oil film continuous between brass and journal throughout the entire arc, are definitely shown in the theory, so long as the brass has a circular section.

The theory shows that the ultimate limit to the load will be the same with the oil-bath and with partial lubrication as Mr. Tower found it to be.

The effect of the limited length of bearings, and the escape of the oil at the ends, is also apparent in the equations.

Although in the main the present investigation has been directed to the circumstances of Mr. Tower's experiments, namely, a cylindrical journal revolving in a cylindrical brass, the main object has been to establish a general and complete theory based on the hydrodynamical equations for viscous fluids. Hence it has been thought necessary to proceed from the general equations, and to deduce the equations of lubrication in a general form, from which the particular form for application has been obtained. It has been found necessary also to consider somewhat generally the characters of fluid friction and viscosity.

The verification of the equations for viscous fluids under such extreme circumstances affords a severe test of the truth and com-

[1] An inch being unit of length, a pound unit of force, and a second unit of time, for olive oil

$$\mu = 0{\cdot}00004737 e^{-0{\cdot}0221\mathrm{T}} \quad \ldots\ldots \quad (8)$$

[2] $$a = (a_0 + m\mathrm{L})e^{\mathrm{ET}} \quad \ldots\ldots\ldots \quad (117)$$

[3] $$f = \left(\mathrm{A} + \frac{\mathrm{B}}{\mathrm{U}}\right)\mathrm{T} + \mathrm{EAT}^2 \quad \ldots\ldots \quad (120)$$

A + ET represents the rate at which the mechanical equivalent of heat is carried away per unit of temperature; B represents the rate at which it is conducted away.

[1] *On* and *off* sides are used by Mr. Tower to express respectively the sides of approach and recession, as B and A, Fig. 1, the arrow indicating the direction of motion.

pleteness of the assumptions on which these equations are founded; and the result of the whole research is to point to a conclusion (important to natural philosophy) that not only in cases of intentional lubrication, but wherever hard surfaces under pressure slide over each other without abrasion, they are separated by a film of some foreign matter, whether perceptible or not; and that the question as to whether the action can be continuous or not turns on whether the motion tends to preserve the foreign matter between the surfaces at the points of pressure, as in the almost if not quite unique case of the revolving journal, or tends to remove it, and sweep it on one side, as in the action of all backward and forward rubbing with continuous pressure.

The fact that a little grease will enable any surfaces to slide for a time has tended doubtless to obscure the action of the revolving journal to maintain the oil between the surfaces at the point of pressure, and yet, although only now understood, it is this action that has alone rendered machinery or even carriages possible. The only other self-acting system of lubrication is that of reciprocating motion with intermittent pressure and intermittent separation of the surfaces to draw the oil back or to draw a fresh supply. This is important in certain machinery, as in the steam-engine, and is as fundamental to animal mechanism as is the continuous lubricating action of the journal to mechanical contrivances.

Mathematical Society, March 11.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. L. J. Rogers was admitted into the Society.—Prof. Sylvester, F.R.S., read a paper on an instantaneous proof of the expression for the number of linearly independent invariants or seminvariants of a given type, and also of the corresponding expression for reciprocants.—Mr. E. B. Elliott read a paper on ternary and n-ary reciprocants, and Mr. L. J. Rogers read one entitled "Homographic, Circular, and Projective Reciprocants."—Capt. P. A. Macmahon, R.A., communicated a proof of Cayley's fundamental theorem of invariants, and Mr. Leudesdorf communicated a note by Mr. Griffiths, on the invariantisers of a binary quantic.—Mr. Tucker (Hon. Sec.) called the attention of the Society to a paper read before the Royal Irish Academy (January 26) by Dr. Casey, F.R.S., entitled "On the Harmonic Hexagon of a Triangle," in which properties established by himself for a harmonic quadrilateral were beautifully generalised and extended to the harmonic hexagon and other harmonic polygons. The harmonic hexagon is thus defined:—ABC is any triangle, AA', BB', CC' its symmedian lines, which meet the circumcircle in $A'B'C'$; the figure $AB'CA'BC'$ is the harmonic hexagon. Dr. Casey calls the triangles $A'B'C'$, ABC co-symmedian triangles.—Mr. Tucker then communicated, for the Rev. T. C. Simmons, the following extensions:—Let K'' be the inverse point of the symmedian point K with respect to the circumcircle, and let $K''A$, $K''B$, $K''C$ meet this circle in $A''B''C''$; then $A''B''C''$ may be called the inverse cosymmedian triangle of ABC. What Dr. Casey has proved for co-symmedian triangles, Mr. Simmons shows also for these inverse triangles, and the result is that the three sets of triangles have the same Brocard points, symmedian point, Brocard, "T. R.," sine and cosine circles.—Mr. Simmons also sent a construction for finding a triangle whose Brocard points and angle are given, whence he proves that *any* triangle inscribed in a certain circle and circumscribed to the Brocard ellipse has the given Brocard points for B. points.

Linnean Society, March 4.—Sir John Lubbock, Bart., F.R.S., President, in the chair.—Messrs. Gilbert C. Bourne, William H. Catlett, and Thos. A. Cotton were elected Fellows of the Society.—One of nine volumes of water-colour drawings of British plants, by the late Miss Moseley of Great Malvern, was exhibited for Miss Onslow.—A paper on *Strongylus Arnfieldi* and *S. tetracanthus*, by Prof. Spencer T. Cobbold, was read, and specimens illustrating the encysted stage of the latter exhibited. Of Arnfield's strongyle he drew attention to the morphology of the hood and its rays, the position of the vulva, and the structure of the embryo, contrasting these with those of allied forms. Regarding his observations on the four spined strongyle these may be summarised as follows:—(1) The eggs are expelled from the parent in a state of fine yolk-cleavage; (2) embryos are formed after egg expulsion, and a few days subsequently escape from the envelopes, undergoing a primary change of skin in moist earth during warm weather; (3) thereafter they live many weeks as rhabdiform nematoids; (4) in all likelihood an intermediary host is unnecessary; (5) the rhabdiform larvæ are passively transferred to their equine bearers either with fresh-cut fodder, or while the animals are grazing; (6) transferred to the intestinal canal they enter the walls of the cæcum and colon, encyst themselves, and undergo change of skin; (7) their presence in the intestinal walls is associated with certain pathological conditions, frequently fatal to the bearer; (8) ordinarily the young worms perforate their cysts and migrate to the lumen of the bowel, and indications of sex appear at this the "Trichonema stage"; (9) they next form cocoons by agglutination of vegetable debris within the gut, and undergo a third skin-casting, with intestinal metamorphosis; (10) lastly, their internal sexual organs and the completion of definite form are acquired within the colon of the host.—A paper was read by Mr. G. Murray on a new species of *Rhipilia* from the Mergui Archipelago. This was collected by Dr. J. Anderson (of Calcutta Museum) in 1882, and recently presented to the British Museum. It was found growing on mud flats at King's Island Bay. The genus *Rhipilia* was established by Kützing for the reception of two species—*R. tomentosa* and *R. longicaulis*—collected by Sonder in the Antilles. To these Prof. Dickie added *R. Ransoni* from Barbadoes. The new species, *R. Andersoni*, differs from the two former in the frond being completely sessile on the mass of rhizoids, and from the latter in the sessile frond being entire. A hitherto unidentified, imperfect specimen brought by Cumming from the East (Philippines?) is now found to be identical with Dr. Anderson's example, which is well preserved in spirit, and thus the Oriental habitat of the genus is corroborated. The author describes minutely and illustrates the remarkable rhizoid filaments of *R. Andersoni*.—A second paper was read by Mr. G. Murray, viz. on two new species of *Lentinus*, one of them growing on a large *Sclerotium*.—Mr. J. G. Baker afterwards gave orally the gist of a communication on a collection of ferns made in North Borneo by the Bishop of Singapore and Sarawak.

Physical Society, February 27.—Dr. J. H. Gladstone in the chair.—Dr. Sydney Young and Mr. D. E. Jones were elected members of the Society.—The following communications were read:—The relations of pressure, temperature, and volume in saturated vapours, by Prof. W. C. Unwin. In the first part of this paper certain formulæ given by Messrs. Ramsay and Young in a recent communication on some thermodynamical relations are criticised. The most important of these is the statement that for different saturated vapours at the same pressure $p\frac{dp}{dt}$ is constant. Prof. Unwin finds, however, that $t\frac{dp}{dt}$ is less constant than $t^2\frac{dp}{dt}$, while $\frac{t^2}{p}\frac{dp}{dt}$ is nearly a constant quantity for all saturated vapours under any conditions. This result suggested that

$$\frac{t^{n+1}}{p}\frac{dp}{dt}$$

might be more nearly constant, and the integration of this gives

$$\log p = a - \frac{b}{t^n},$$

a formula to the examination of which the second part of the paper is devoted. From it may be derived the following relations in which for convenience in calculation the logarithms given are to the base 10.

$$t = \left(\frac{b}{a - \log p}\right)^{\frac{1}{n}}$$

$$\frac{1}{p}\cdot\frac{dp}{dt} = 2{\cdot}3025\,\frac{nb}{t^{n+1}}$$

$$= 2{\cdot}3025\,n\,\frac{(a - \log p)^{\frac{n+1}{n}}}{b^{\frac{1}{n}}}$$

$$\frac{t}{p}\cdot\frac{dp}{dt} = 2{\cdot}3025\,\frac{nb}{t},$$

&c. These formulæ have been examined in the case of steam from − 30° to 230° C., and with pressures varying from ·4 to 20,000 mm. The constants were found to be

$$a = 7{\cdot}5030 \;\ldots\; b = 7579 \;\ldots\; n = 1{\cdot}25,$$

and the differences between the calculated results and the observations of Regnault and Zeuner rarely exceeded 1 per cent., while generally much smaller. a, b, and n have also been found for some other substances, with the following results:—

Alcohol	$a = 7{\cdot}448$ ...	$b = 8784$ ...	$n = 1{\cdot}29$
Ether	$a = 6{\cdot}9968$ ...	$b = 3047$ ...	$n = 1{\cdot}153$
Mercury ...	$a = 9{\cdot}8651$ ...	$b = 597{\cdot}5$ ...	$n = {\cdot}69$
Carbonic acid	$a = 8{\cdot}4625$ ...	$b = 302{\cdot}8$ ...	$n = {\cdot}77$

Prof. Perry offered some criticisms upon this paper, and believed that for practical purposes the expressions given would not be found superior to Rankine's formula

$$\log p = a - \frac{b}{t} - \frac{c}{t^2},$$

which gives p in terms of t, and and a quadratic expression for obtaining t in terms of p. He also observed that the chief aim of Ramsay and Young's paper was to obtain relations between the pressure and temperature of different saturated papers, so that the connection between temperature and pressure having been observed and recorded for one vapour, that for any other vapour could be at once deduced from it.—On a map of the world in which the proportion of areas is preserved, by Mr. Walter Baily. The author had devised a method for constructing such a map, but has subsequently found that one precisely similar was employed by Flamsteed in 1729 for charting the stars in his "Atlas Cœlestis." The construction applied to the earth is briefly as follows. Draw a straight line to represent the meridian that is to occupy the centre of the map. Divide this line into equal parts representing upon a convenient scale the distance between the parallels of latitude, and through these points draw a series of lines at right angles to the original line; these are the parallels of latitude. Mark off on these the actual distances at which the meridians cut them; through the points so found the meridians may be filled in, and the map constructed. From the method of construction it is evident that, although the outlines in the map are distorted, the amount of distortion increasing with the distance from the central meridian, the proportionality of areas is preserved, a fact which the author believes will render the map useful for recording rainfall, depth of sea, ocean currents, &c.—On a delicate calorimetric thermometer, by Prof. S. U. Pickering.

EDINBURGH

Royal Society, February 1.—Mr. J. Murray, Vice-President, in the chair.—Several obituary notices were read.—Dr. Thomas Muir read the second part of a paper on the theory of determinants in the historical order of its development.—Mr. G. Brook communicated a paper on the origin and formation of the germinal layers in the Teleostei.—Mr. A. C. Mitchell described the results of experiments on the thermal conductivity of ice. A method involving periodic variation of temperature was used.

February 15.—Mr. R. Gray, Vice-President, in the chair.—Mr. W. Durham read a paper on chemical affinity and solution.—Mr. J. T. Cunningham, of the Scottish Marine Station, read a paper on the reproductive elements of *Myxine glutinosa*.—Dr. J. R. Buist communicated a paper on the life-history of the micro-organisms associated with Variola and Vaccinia.—Mr. A. P. Laurie discussed the probable heats of formation of zinc-copper alloys, as determined by observations on the E.M.F. of constant voltaic cells with the alloys as negative elements. His results indicate the formation of a compound of the formula $CuZn_2$ with an evolution of heat producing a fall of E.M.F. equal to 0·5 volt.—Prof. Tait, in a paper on the mean free paths in a mixture of two systems of spheres, generalised his results as given in previous papers.—Prof. Duns read a paper on two shrunk human heads from South America.

March 1.—Prof. Douglas Maclagan in the chair.—Sir W. Thomson read a paper on the magnitude of the mutual attraction between two pieces of matter at distances of less than 10 micro-millimetres.—Prof. Tait read a paper on a theorem in the science of situation.—Mr. John Aitken communicated a paper on radiation from snow, and also a paper on thermometer screens.—Mr. J. H. Pollok discussed the relation between the volume of an aqueous solution of a salt and the sum of the columns of its constituents.—Mr. W. Peddie read a paper on the increase of electrolytic polarisation with time.

Mathematical Society, March 12.—Mr. W. J. Macdonald in the chair.—Mr. Harry Rainy read a paper on bifilar suspension treated by the method of contour lines, and Mr. J. S. Mackay gave an abstract, with notes, of a paper of Euler's, entitled "Solutio facilis problematum quorumdam geometricorum difficillimorum."—A conversation took place regarding work to be done under the auspices of the Society by groups of members, with the result that investigations were undertaken on linkages, projective geometry, and the bibliography of mathematical periodicals.

PARIS

Academy of Sciences, March 8.—M. Jurien de la Gravière, President, in the chair.—Foundation of a hospital for the treatment of rabies. The following articles have been adopted by the Commission appointed by the Academy to promote this object:—(1) An establishment for the treatment of rabies after the bite of a mad animal shall be founded in Paris under the title of "Institut Pasteur"; (2) this Institute shall admit Frenchmen and foreigners bitten by dogs or other mad animals; (3) a public subscription shall be opened in France and abroad for the foundation of this establishment; (4) the funds thus raised shall be applied under the direction of a Committee appointed for the purpose; (5) subscriptions received by the Bank of France and its branches, the Crédit Foncier and its branches, the Treasury, and public receivers. Names of all subscribers to be inserted in the *Journal Officiel*. Amongst the Committee are the names of MM. Jurien de la Gravière, Pasteur, Bertrand, Vulpian, Marey, Paul Bert, de Freycinet, Magnin (Governor of the Bank of France), Baron Alphonse de Rothschild, and the Perpetual Secretaries of the Academies of Sciences, Inscriptions et Belles Lettres, Beaux Arts, and Moral and Political Sciences.—Determination of the elements of refraction: the most convenient practical solution of the problem, by M. Lœwy. Compared with the older methods here passed in review, the new process enables the observer to obtain in a single month a greater precision than was formerly possible after fifteen years of observations and researches of all sorts required to determine the instrumental constants.—Remarks on the danger of fire arising from the use of nitric acid in the manufacture of certain industrial objects, and especially of explosive substances, such as gun-cotton and dynamite, by M. G. Lechartier. Several instances are mentioned of straw and other organic substances when heated, and even at a low temperature, taking fire by accidental contact with this acid.—Equatorial observations of Brooks's, Barnard's, and Fabry's comets, made at the Observatory of Bordeaux in February 1886, by MM. G. Rayet and Courty.—Observation of the nebula in Maia, by M. Perrotin. In a letter addressed from Nice to M. Mouchez the writer states that by masking Maia he was able distinctly to observe the nebula discovered by MM. Henry, first on February 28, and again, in company with MM. Thollon and Charlois, on March 3 and 4.—On the construction of objectives for instruments of precision, by M. Léon Laurent. The objectives here described and illustrated have been executed by practical methods, which, according to the author, yield the best possible results. They have a diameter of 70 mm. with focus 735 mm.—On the isomeric states of the sesquichloride of chromium: gray hydrated chloride; anhydrous chloride, by M. A. Recoura. The author's researches have led to the determination of two isomeric varieties—a gray chloride and a green chloride, with which latter is connected the violet anhydrous chloride. Dissolved in water, both varieties constitute two extreme states capable of being transformed one into the other by passing through all the intermediate states, the gray-blue solution constituting the stable state of the extended solutions, the green solution the stable state of the highly-concentrated solutions. In another paper it will be shown that these are not the only varieties of chloride.—Note on a combination of methylic alcohol and sulphate of copper, by M. de Forcrand.—On the action of ammonia and water on chloroform, by M. G. André. Some details are given regarding the use of ammonia in aqueous solutions, with indications of the relative proportions of the products resulting from this reaction.—Note on the action of picric acid on terebenthene and on thymene, by M. Lextreit.—On the histogenesis of the elements contained in the ovaries of insects, by M. J. Perez.—On the anatomy of the reproductive organs of Pontobdella (*P. muricata*, Leach), by M. G. Dutilleul.—A contribution to the study of the Miocene palms of Brittany, by M. Louis Crié.—On the distribution of inverted formations in the region of the Jura comprised between Geneva and Poligny, by M. Bourgeat.—Note on a method of direct analysis of rocks by means of their physical properties, by M. Thoulet. The physical properties of which the author avails himself in this process are weight, specific heat, density, and the coefficient of cubic expansion (variation of density with temperature), the two last being easily determined even with small samples by means of the fluid of iodides already recommended by him.—Remarks on M. Mushketoff's orographic and geological description of Turkestan, by M. Daubrée. Of the three volumes of explanatory text to the map of Russian Turkestan (scale 1 : 1,250,000), the first has now appeared. It contains a summary of the explorations of Turkestan from the remotest times down to the year 1884, and a geological description of the Aralo-Caspian steppes, with a small geological map of Turkestan.

BERLIN

Physical Society, January 22.—Dr. König spoke of some photometers he had quite recently tested in respect of their precision. The simple Bunsen photometer, consisting of a screen of fine writing-paper smeared with a grease spot, laboured under the drawback that it was not possible to contemplate simultaneously the two sides it was desired to compare. There were several modifications of this apparatus planned with a view to overcoming this defect. First, there was the application of two mirrors inclined at 45°, by means of which both surfaces were seen in juxtaposition. Other contrivances for the same purpose were the application of a prism, the edge of which lay in the plane of the screen, the use of two prisms, and, further, the use of two totally reflecting prisms with lenses. The last-named description of photometer, as also the mirror-photometer, were very exact, but it now appeared that it was not possible to cause the spot of grease wholly to vanish from view. For such precise photometers there would, on the contrary, have to be found two substances which reflected and transmitted the light differently, but yet absorbed it with equal strength and possessed the same structure. Weber's photometer was constructed according to an entirely different principle. It consisted in the main of a small benzene lamp, which was placed in a tube in front of a mirror and which illumined a milk-glass plate displaceable in the tube. From the illumined milk-glass the light was carried to a totally reflecting prism, and thence into the eye-piece, where it lighted up the half of the field of vision. The other half received light from a milk-glass plate standing in the direction of the eye-piece behind the prism. This milk-glass plate was illumined by the light which was to be measured. In the case of like-coloured light the registrations of the Weber photometer were very exact, but in the case of different-coloured lights such precision was not obtained. Of the means employed by Herr Weber to measure different-coloured lights with his photometer, that which consisted in bringing first a red, then a green, and thereafter a blue glass before the eye-piece, and taking the average of the three measurements, was still at this day the most approximately exact, but was yet inadequate. A great advantage belonging to the Weber photometer, on the other hand, was that by means of it the scattered daylight could be measured. The readily available Weber photometer would prove itself particularly useful for the purpose of testing the conditions of illumination in school-rooms.—Dr. Grunmach reported on the barometric investigations carried out by him in the Normal Gauging Office. He described at length the arrangement of the normal barometer, the vacuum of which was measured in an electrical way. A combination of the barometer-vacuum with a Geissler tube permitted the attenuation to be examined even beyond the limits of the pressures measurable by the cathetometer. The occurrence of the phosphorescence light in the spectral tube was a standard for the highest degrees of attenuation, in which the vacuum was filled with quicksilver vapour of the tension of only 0·01 to 0·02. A still better vacuum would be achieved when the quicksilver vapour was made to be absorbed, a condition which the speaker had in vain tried to effect with selenium. With this barometer was compared a large number of normal barometers according to a method described at large by the speaker, and with the application of the developed formulæ of reduction. Under these comparisons it appeared that the impurity of the free quicksilver-cup heightened the meniscus, and thereby the registrations also of the barometer. In the case of older barometers, a series of other disturbing influences likewise showed themselves, which would have to be further investigated. In the discussion which followed this address, Dr. Goldstein proposed for the electrical measurement of the vacuum, instead of Geissler's spectral tube, the employment of a wide tube which let the fluorescence light pass more obviously into the phenomenon; and for the graduations of these highest degrees of attenuation the thermometer would, he maintained be better adapted than were the optical phenomena. Let, namely, a thermometer be brought into a vacuum-tube whose positive pole was a point, but whose negative electrode was a steel plate nearly filling out the tube in front of the cathode; then the thermometer, when the attenuation reached such a degree that the cathode light appeared would mount 80° to 90° above the temperature of the room. At the positive pole the thermometer rose only about 3°. This rise of temperature in the cathode light occurred in connection with the degree of attenuation, and might be utilised for the measurement of these degrees.

BOOKS AND PAMPHLETS RECEIVED

BOOKS :—"Schriften der Naturforschenden Gesellschaft in Danzig," Neue Folge, Sechsten Bandes, Drittes Heft (Danzig).—"The Construction of Harbours," 3rd edition, by Thos. Stevenson (A. and C. Black).—"Three Years of Arctic Service," 2 vols., by A. W. Greely (Bentley).—"The Quarterly Journal of Microscopical Science," February (Churchill).—"Frictional Electricity," by T. P. Treglohan (Longmans).—"Hand-Book of the History of Philosophy," by E. Belfort Bax (Bell).—"Treatise on Statics," vol. ii., 3rd edition, by J. M. Minchin (Clarendon Press).—"Analisi delle Ipotesi Fisiche," by C. Zanon (Fondelli, Venice).—"Proceedings of the American Academy of Arts and Sciences," May to October 1885 (Wilson, Boston).—"Transactions of the Anthropological Society of Washington," vol. iii.—"Proceedings of the Academy of Natural Sciences of Philadelphia," part 3 (August to December 1885).—Memoirs of the Geological Survey of India: "Palæontologia Indica," ser. x.; "Indian Tertiary and Post-Tertiary Vertebrata," vol. iii. parts 7 and 8; "Siwalik Crocodilia, Lacertilia, and Ophidia, and Tertiary Fishes," by R. Lydekker (Trübner).—"Hong Kong Observatory Reports," May to November 1885.—PAMPHLETS :—"On the Movement Cure in China," by D. J. Macgowan.—"The Present Position of the Museum and Art Galleries of Glasgow, 1886" (Anderson, Glasgow).—"Twenty-ninth Annual Report on Free Public Libraries and Museum of Sheffield."—"Les Crânes dits Déformes," by J. Ignaciode Armes (Havane).—"Cellulose," by C. F. Cross and E. J. Bevan (G. Kenning).—"Separatabdruck aus dem Repertorium der Physik," by Dr. F. Exner.—"The Typhoons of the Chinese Seas in the Year 1885: Essay on the Atmospheric Variations in the Far East during January 1885," by R. P. Marc Dechevrens (Kelly and Walsh, Shanghai).

CONTENTS

THURSDAY, MARCH 25, 1886

THE GREELY ARCTIC EXPEDITION

Three Years of Arctic Service. An Account of the Lady Franklin Bay Expedition of 1881–84, *and the Attainment of the Furthest North.* By Adolphus W. Greely, Lieutenant U.S. Army, Commanding the Expedition. Two Vols. (London: Bentley and Son, 1886.)

THE principal incidents of this wonderfully successful and singularly unfortunate Expedition must be familiar to most of our readers. It formed one of the series of International Polar Stations which carried on a year's observations all round the Polar area in 1882–83. The Greely Expedition, however, took up its quarters at Fort Conger (81° 44′ N., 64° 45′ W.), Discovery Harbour, Lady Franklin Bay, in August of 1881. This, it will be remembered, was the station of the *Discovery* in the last English Expedition. The Expedition consisted of twenty-five men, all told. So far as organisation goes, the Expedition was a military and not a naval one, under the U.S. Signal Service, which is attached to the War Department. It was certainly a mistake not to have had the naval element substantially represented on such an expedition, and a still greater and more fatal blunder not to have provided the party with a ship in which they might have escaped in case no relief party reached them. No time was lost after landing in erecting a substantial wooden house, observatory, and the various instruments with which the scientific work of the Expedition was to be carried on. Observations in all departments of meteorology seem to have been faithfully and regularly taken according to the prescribed programme, and we have no doubt that most of them were preserved and taken home in the rescue ship. Only a few of the results are given in the appendixes to these volumes; the observations themselves will doubtless be sent to the Central Committee to be worked out along with those from other stations. Under the very efficient guidance of Major Greely excellent work of various kinds was carried out in the autumn of 1881 and the spring and summer of 1882. The relief vessel which was sent out in the latter year failed to come near Fort Conger, and the party, well provided, continued their work in the autumn of 1882 and up to the end of August 1883. Two vessels were sent out in the summer of 1883 to reach Fort Conger, but through incredible mismanagement, completely failed in fulfilling their mission, and even carried back with them the bulk of the provisions which they ought to have cached at certain points for the sustenance of the retreating party. It seems a strange perversity and a remarkable piece of red-tapeism in the U.S. Government to have intrusted these relief expeditions entirely to military men. It would surely have been easy to get experienced Arctic navigators for such critical work, and so probably have saved the lives of the poor men who were practically without the means of saving themselves. According to instructions, Major Greely, since no relief reached him, abandoned his station at Fort Conger on September 1, 1883, and with all his men, who up to this time had enjoyed excellent health on the whole, made his way south in a small steam launch and a boat or two, through almost impassable ice. In the end they were forced to land at Cape Sabine about the middle of October, and here, with scarcely any shelter, with only about enough food to sustain one man in these regions, and under the most miserable meteorological conditions, on the bleakest spot in all the Arctic, did these men drearily drag themselves through the winter. When at last Commander Schley did reach the spot in June 1884, he found only six out of the twenty-five alive. Yet up to within a few days of the rescue, such observations as were possible were carried on, and the conduct of the men, on the whole, was as noble as could be imagined. This fearful sacrifice of life is deplorable, all the more so when it is remembered that it was due to blundering and half-heartedness on the part of those at home. It is easy to ask whether the gains to science are worth all this sacrifice to human life, but the question is not so easily answered. And whatever the answer is, we may be sure that the Greely disaster will never deter humanity from attempting to find out all about the remotest and most inhospitable corners of its little home.

During the two years that the Expedition remained in Grinnell Land, it did some admirable work, in addition to the scientific observations carried out in the neighbourhood of the station. One of the most efficient and bravest members of the Expedition was Lieut. Lockwood, who, alas, did not return to reap the reward of his splendid work. He, along with Sergeant Brainard (who, we are glad to believe, will receive an acknowledgment of his services from the Royal Geographical Society), carried the coast of Greenland far beyond the furthest point reached by Beaumont in the Nares Expedition. In doing this, Lockwood reached the furthest point northwards yet attained, 83° 23′·8 N., only three or four miles beyond Capt. Markham's farthest. Of course he was quite justified in waving the Stars and Stripes over this triumph; though it should be remembered that it is a very different thing to travel along an Arctic coast to trudging straight Polewards over palæocrystic ice. As far as Lockwood reached, the coast of Greenland is broken up by fjörds, and skirted with islands, while the interior seemed an ice-bound land. There now remains only a comparatively small section of the north coast of Greenland to lay down, in order to join the furthest points east and west; and it is much to be wished that this section were completed. At the same time if an expedition were sent out specially for the purpose, it would be desirable to endeavour to penetrate southwards into the Greenland interior, to test Sir Joseph Hooker's conjecture, "that vegetation may be more abundant in the interior of Greenland than is supposed, and that the glacier-bound coast-ranges of that country may protect a comparatively fertile interior." It was in search of a green interior, it will be remembered, that Baron Nordenskjöld made his remarkable journey a few years ago. He failed to find what he sought for, probably because he struck too far south.

In another direction Sir Joseph Hooker's prophetic faculty has been amply sustained. "We are almost driven to conclude," he wrote in 1877, "that Grinnell Land as well as Greenland, are, instead of ice-capped, merely ice-girt islands." The most noteworthy and novel geographical work done by the Greely Expedition was the exploration of this same Grinnell Land. Previously we only knew its coasts and the country bordering on them in the neighbourhood of Discovery Harbour. Aldrich carried the north coast as far west as 85° W. long. Much of this outline has now been filled up. Archer Fjörd has been traced to its head; a large portion of the interior has been opened up; while on the southern coast another fiord, Greely Fjörd, has been discovered, and the coasts beyond seen stretching northwards and southwards. In the spring and summer of 1882 Greely himself made two considerable journeys into the interior, when he made discoveries which form an important addition to our knowledge of the physical geography of the Arctic regions. Bordering on 82° N. is a considerable freshwater lake (Hazen), skirted on the north by the lofty Garfield and United States Ranges and westwards by the Conger Mountains. Around Lake Hazen are a series of small lakes, and many streams which send their waters into Lake Hazen. Even in April the river which discharges into Chandler Fjörd was found quite open in part of its course, and the country generally remarkably free of snow. In summer the valleys give birth to a comparatively luxuriant vegetation, which serves as pasturage for considerable game. Besides grass in plenty, willows, beds of dryas and saxifrages were common; butterflies added brightness and gaiety to the scene; bumble-bees and "devil's darning-needles" flitted about. Ample remains of recent Eskimo settlements were found, and fossil testimonies to the former temperate character of the climate and the recent elevation of the whole region. Unfortunately, though very excellent collections seem to have been made, none of the members of the Expedition were specially qualified to make the most of the rare opportunity for thorough scientific investigation. Many Eskimo relics were collected, but a study on the spot of the sites of dwellings and remains by one skilled in such investigations would have yielded valuable results to ethnology. Still Major Greely and his men did their best, and the collections they made and information they collected will form important and welcome additions to science. Even on the south side of Archer Fjörd, near Cape Baird, a fossil forest was discovered, one tree over a foot in diameter being found at an elevation of 800 feet above the sea. Of Grinnell Land Major Greely writes: "This fertile belt, 150 miles long and 40 wide, extends from Robeson and Kennedy Channels to Greely Fjörd and the Western Polar Ocean. Its iceless condition depends entirely on its physical configuration. The abrupt, broken character of the country makes it impossible for the winter's scanty snow to cover it. Long, narrow, and numerous valleys not only offer the greatest amount of bare soil at favourable angles to the heating rays of the constant summer sun, but also serve as natural beds, with steep gradients, for the torrents from melting snows. The summer rivers drain rapidly the surface water, and long before continuous and sharply-freezing weather comes, the land is generally free from snow, and the large rivers have dwindled to brooks. The deep intersecting fjörds not only receive the discharging rivers, but, from their frozen surfaces, furnish large quantities of saline efflorescence, which, mixing with the land-snow, facilitates greatly its disappearance in the coming spring. Where such conditions do not prevail in Grinnell Land, ice-caps are found similar to the inclosed ice of Greenland traversed by Nordenskjöld."

Abutting on the north shore of Lake Hazen through a gap in the Garfield Range, is a magnificent glacier, with a convex face some five miles long, and 150 feet high, an outlier of the great ice-cap which covers all the north of Grinnell Land. Major Greely estimates the area of this northern ice-cap at 3000 square miles. "There is but little doubt," he says, "that the Challenger Mountains bound this ice-cap to the north-west, and that its northern face drains through Clements Markham Inlet, and the many ravines which Aldrich speaks of as running far inland from the bays on the shores of the Polar Sea."

Similarly on the south side of this Arctic oasis Lockwood and Brainard found a magnificent glacial wall extending between Archer Fjörd and Greely Fjörd, with a vertical face of an average height of 150 feet. From one mountain the wall was seen trending for forty miles to the south-west. The surface of the Agassiz *mer-de-glace* itself is very elevated, and extended southwards as far as the eye could reach. Lockwood thought that it must be of enormous depth in the interior. No moraines or foreign matter of any kind were observed on the surface, and crevices were extremely few and insignificant. Of moraines along the wall there were very few. The wall was generally of a uniform white colour. The ground to the north of it, especially on the divide, had a singularly smooth appearance, as if it had once formed the base of this mass of ice. We have here evidently a region of singular interest, well deserving the study of the geologist, and especially of the palæontologist.

Major Greely devotes a chapter to Polar ice, in which he describes some of its more usual forms; this having already been very exhaustively done by Nordenskjöld in his "Voyage of the *Vega*." Major Greely, however, specially discusses the formation of palæocrystic ice. It will be remembered that Sir George Nares attempts to account for the formation of these enormous thick masses of floating ice by supposing that they are due to successive accretions at the base. Major Greely rebuts this hypothesis, and maintains that the origin of palæocrystic bergs is similar to the flat-topped bergs of the Antarctic. He believes that the ice is in origin a land-formation, probably the accumulation of centuries on some islands far to the north of Grinnell Land; that it gets shunted off into the sea, and is floated southwards towards Robeson Channel. We suspect that neither hypothesis can be considered satisfactory; and though we do not think Major Greely has much to advance in favour of his hypothesis, his description of the structure of these great floes is at least instructive. The tidal observations made regularly during the two years are likely to lead to valuable results. Not only were observations taken at Fort Conger, but simultaneous observations, when possible, were taken along Grinnell Land coast. These, combined with the observations of 1875 and those of Bessel in 1871, may enable us to determine satisfactorily the cotidal curves of Robeson and Kennedy Channels and the entrance to the Polar Sea.

Much exploration, it should be said, was also carried out along all the coasts around the Station, and Dr. Pavy made an unsuccessful attempt to push northwards from Cape Joseph Henry. Very fair supplies of musk oxen were met with, and no doubt had the Expedition disobeyed instructions and remained at Fort Conger, it would have been saved most of the hardships it encountered, and all the members might have been saved alive. Much valuable scientific matter will be found in the appendix—ethnology, botany, ornithology, Medusæ, &c. One of the most striking and instructive features about these handsome volumes is the beauty and accuracy of the illustrations. They are most of them from photographs, and are fine examples of the services which photography can render to science. The texture of rocks and ice in these illustrations is wonderful.

The narrative itself, though quite unvarnished, is of intense interest; and the Expedition was in many ways one of the most remarkable ever sent Polewards.

THE KRAKATÃO DUST-GLOWS OF 1883-84

Beobachtungen über die Dämmerung insbesondere über das Purpurlicht und seine Beziehungen zum Bishop'schen Sonnenring. Habilitationsschrift der philosophischen Facultät der Universität Basel vorgelegt von Dr. Albert Riggenbach. (Basel: H. Georg's Verlag, 1886.)

THE Krakatão dust-glows of 1883-84 have already created a not inconsiderable literature. To this the pamphlet now before us is a contribution of some value. The writer has not only diligently studied the observations of others, but has added a long series of his own, and has thus acquired a right to an attentive hearing on the subject of the remarkable appearances which have given rise to so much discussion.

Scientific opinion has all but unanimously adopted the volcanic hypothesis of their origin urged with irresistible logic by Mr. Lockyer in the *Times* of December 8, 1883. It is admitted, though not examined, by Dr. Riggenbach; whose concern is less with the primary cause of the phenomena than with the minute machinery of their production. Questions bearing on the general physics of the globe are left untouched, while attention is concentrated on the intricate optical problems connected with the variegated tints of our skies.

These, according to our author, result mainly from diffraction. But absorption and reflection also play each an indispensable part. The sunset-sky, it must be remembered, is illuminated only by a residuum of sunlight. A long journey across the densest strata of the atmosphere has robbed it of all its more refrangible constituents. The course of the surviving rosy beams is interrupted by encounters with innumerable fine particles of solid matter, always, in greater or less quantity, suspended at considerable heights above the earth's surface. These form fresh points of divergence, whence rays which would otherwise have been transmitted unseen, reach the eye, either directly, or after reflections from interposing veils of fine cloud. Thus, the hurling into the air of 150 cubic kilometres of volcanic dust in August 1883, served only to intensify pre-existent conditions for the production of twilight-pageantry, not to create new ones. What we might almost call the solid constituents of our atmosphere were not alone largely increased in amount, but the added dust-supplies were of unusual fineness, consequently floated at unusual elevations. Displays of colour hence gained both in splendour and duration.

The effects of this strange reinforcement from the antipodes did not, however, manifest themselves at sunrise and sunset only. On September 5, 1883, Mr. Sereno G. Bishop first noticed at Honolulu a peculiar white halo of a pinkish tint encircling the sun (NATURE, vol. xxix. p. 260). The phenomenon had never previously been observed, and is now known as "Bishop's Ring." It was perceived later in Europe, and proved extraordinarily persistent. For fully two years, whenever the air was sufficiently clear, it continued visible, thus long outlasting the twilight-glows, with which, nevertheless, it was most intimately connected. Dr. Riggenbach observed that the rosy illumination began to show after the sun had dipped below the horizon, precisely at the same angular distance from his limb with the maximum intensity of the ring or "corona." And it may be taken as ascertained that the latter was purely an effect of diffraction. The succession of colours was the opposite to that seen in an ordinary halo, the blue lying *inside*; while the diameter (measured to the middle of the red zone) was about 28°, that of the refraction-halo being 45°. The observed dimensions of the ring gave the means of calculating the size of the particles concerned in producing it; and they were accordingly found by Prof. Hagenbach to be 0·003 mm., by M. Flögel 0·001 mm. in diameter. Yet, though far finer than the minute vesicles occasioning the diffraction-rings frequently observed in comparatively close proximity to the sun and moon, their bulk (even adopting the lower estimate) would still be at least one million times that assigned by Sir William Thomson to the ultimate atoms of matter.

Seen from the Bernese Oberland, or other high ground in Switzerland, during the summer and autumn both of 1884 and 1885, this curious aureola presented a striking appearance. A silvery field of diffused radiance extended to about 10° from the sun's limb, and was terminated by coloured circles, the prismatic order of which grew distinct in proportion as the air gained transparency. Below 1000 metres of elevation, the whole phenomenon became effaced. It was independent of meteorological conditions, taking its origin in a region of the atmosphere beyond the reach of ordinary disturbances. The invariability of its presence was painfully experienced by Mr. C. Ray Woods during his sojourn on the Riffel in the summer of 1884. No more effectual obstacle to the work of photographing the sun's proper corona can indeed be imagined than that which, by a linking of causes not difficult to trace, though impossible to foresee, was interposed by the memorable eruption two and a half years ago in the Sunda Straits.

OUR BOOK SHELF

The Star Guide. By Latimer Clark, F.R.A.S., and Herbert Sadler, F.R.A.S. (London: Macmillan, 1886.)

THIS is a most useful and carefully planned guide to the best use of small telescopes. It consists of a list of the most remarkable celestial objects visible with such instruments, with their positions for every tenth day, and partly serves as an introduction to Webb's "Celestial Objects for Common Telescopes." Very considerable trouble has been taken in the compilation of the table of double-stars. Test objects, lunar craters, shooting-star radiants are also catalogued, and although small apertures are principally considered, objects suitable for examination with larger ones up to seven inches are given.

Much trouble has been taken with a very convenient result; and as the author shows what corrections to apply to make the volume useful in future years, we must regard it as one of the most useful books an amateur astronomer can possess.

Practical Introduction to Chemistry. By W. A. Shenstone. Lectures on Chemistry in Clifton College. (London: Rivingtons, 1886.)

ALTHOUGH several courses of practical chemistry for beginners have lately been introduced the author has not found any of them suitable for school work, and so he has undertaken to write one himself.

In his selection of experiments, he says he has been guided by two main considerations. First, that they should be suitable for the young boys who chiefly will have to perform them, and who will have but a limited amount of time to do them in. Secondly, that when completed they shall constitute a body of experience which shall be as valuable as possible to appeal to when the students pass to the classes which have lecture teaching.

The first three chapters deal briefly with the elements, compounds, acids, &c. Chapters IV. and V. deal with the law of chemical combination and the classification of chemical changes; Chapters VI. and VII. with the decomposition of water and air. Chapter VIII. is devoted to a few very elementary experiments on the relations between solids, liquids, and gases. In Chapters IX. and X. attention is drawn to the use made of these differences in experiment.

The appendixes contain a list of apparatus and also a description of the balance and how to use it.

The book is divided into two sections. In the first section the student is given instructions how to perform the experiments, but he is not told how they will "come out," so that as the experiment proceeds, he has to observe and note what takes place, and when it is finished he can compare his notes with those given in Section II., where full explanations are afforded. Certainly if this method is well carried out we shall have a vast improvement upon the ordinary "test tubing" process, in which, as a rule, little theoretical construction is given to the beginner. W.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Permanent Magnetic Polarity

SINCE the subject of the permanent polarity of quartz has been brought prominently forward by the researches of Dr. Tumlirz, published in the January number of *Wiedemann's Annalen*, and by the recent discussion of it in your pages, it is perhaps allowable for me to put on record the fact that I have been engaged during the course of this winter with very similar experiments, and have obtained very similar results. Quartz indeed does not happen to be one of the substances I have examined,—I rather dreaded the complexity of crystalline substances,—but my observations have led me to the conclusion that most likely *every* substance possesses some trace of permanent magnetisability or retentivity.

The set of experiments were not indeed begun with the object of looking for permanent polarity, but with a wholly different object, viz. this:—According to the Ampère-Weber theory of magnetism and diamagnetism, wherein magnetism is explained by means of specific molecular currents flowing in channels of no resistance, and diamagnetism by induced currents excited in those same channels by the magnetic field, it is obvious that the permeability of a magnetic body ought to become negative when the magnetising force applied oversteps a certain amount. Because an increasing magnetising force must weaken the specific currents, even though it is unable to excite contrary ones and so cause diamagnetism.

This result of the theory is pointed out by Clerk-Maxwell (vol. ii. § 844, 1st edit.), who further says: "If it should ever be experimentally proved that the temporary magnetisation of any substance first increases and then diminishes as the magnetising force is continually increased, the evidence of the existence of these molecular currents would, I think, be raised almost to the rank of a demonstration."

There are many circumstances now known which point more or less distinctly to such a maximum, but my ambition has been to not only establish a falling off of induced magnetism, but actually to reverse it; to convert, in fact, a feebly-magnetic substance into a diamagnetic substance by immersing it in a sufficiently intense magnetic field.

Accordingly, in October last, I set up a fairly large magnet, with specially-pointed pole-pieces about a centimetre or less apart, and arranged that various strengths of current, ranging from very weak to very strong, might be sent round its coils; the weakest current being given by a Leclanché or two, an intermediate strength by 3 or 4 secondary lead cells, a strong current by 24 such cells, and the greatest strength by about 40 secondary batteries, some of them zinc-lead with $2\frac{1}{2}$ active volts apiece between their terminals, kept charged in two batches by a dynamo.

I then instructed my workshop-assistant, Mr. Benjamin Davies, to fill up his odd time by cutting ellipsoids of all manner of substances (axes about ·6, ·3, ·3), to finish them off with glass-paper, when practicable to boil them in acid, and then to examine their behaviour between the poles of the magnet in a specified way.

The dimensions of the magnet were:—

Diameter of iron core	5 centims.
Length of each leg	21 ,,
Distance from centre to centre ...	15 ,,

Total number of turns of No. 12 B.W.G. wire, 1868, on both legs together.
Resistance of wire 1·1 ohm.
Usual strengths of current, from $\frac{1}{4}$ ampere to 50 amperes.

The thing intended was to discover by trial some substance so feebly magnetic that, though it could just set itself axially with the weakest current, it might lie equatorially with the strongest. But failing this actual change of property it was thought that the rate of oscillation between the poles might diminish for some (non-conducting) substances when the highest powers were applied, instead of increasing.

And meanwhile the behaviour of all the substances was to be noted and carefully recorded, whatever it might be.

In this way a large number of substances, various kinds of wood, all sorts of metal, glass, coke, charcoal, wax, chalk, cardboard, ebonite, &c., have been passed under review; and some one or two of them seemed to behave exactly in the way hoped for. One piece of coke, for instance, vibrated in the intense field more slowly than it did in the feeble one; while another, which vibrated axially in a weak field, set itself nearly equatorially in the strong one. Its behaviour was thus sufficiently like what we wanted to justify a more careful examination.

Soon after this, however, Davies of his own accord inserted a reversing key into the circuit of the Leclanché, and thus made an important observation.

When the *strong* current was reversed, the deportment of the substance remained unaltered, as is natural enough; but directly the *weak* current was reversed, the little suspended piece turned in the magnetic field through 120° or so, and pointed in a symmetrically situate direction on the other side the magnetic axis. The piece of coke, for instance, which may have been pointing some 60° on the one side of the magnetic axis, changed its position when the magnet was reversed, and pointed some 60° on the other side. The suspending thread was not wholly devoid of torsion though it was extremely minute. A piece of electrolytic copper, and a piece of boxwood with the grain longways, were soon afterwards found, which set themselves almost exactly equatorially, and on reversing the magnet turned through very nearly 180°.

I was a little excited about this result at first, because I thought it meant a permanent diamagnetic polarity, that is to say, "*a diamagnet*," which seemed an incomprehensible result. My suspicions were at once aroused, however, as to the possibility of a transverse ordinary magnetisation; and subsequent experience, on the whole, confirms this explanation.

All the substances were then tried over again for permanent magnetic polarity, and not one of them has failed to show it. A piece of wood, for instance (or any other substance), which points axially between the poles, instantly reverses its position, turning through 180°, when the magnet is reversed. But the reversal must be done with the weak current only: anything like a strong current, *e.g.* that from two or three secondary cells, instantly destroys and reverses the permanent magnetism, and no abnormal behaviour is then detected. Some substances, however, retain it better than others. The permanent magnetism requires a strong current to excite it, and a very weak reverse current to detect it. Without these conditions it would certainly have been overlooked. It does not seem to matter whether a substance is magnetic or diamagnetic, it always reverses its position or nearly reverses it when the weak reverse current is applied.

The piece of copper was next *held* long-ways in the field, and a strong current applied. On now hanging it at 45° in the field, and testing it by a weak current, it at once returned to its axial position (though the copper was electrolytically "pure" and decidedly diamagnetic); on reversing the weak current, it at once turned through 180°, setting axially the other way, thus behaving exactly like a weak magnet. When a strong current was applied this behaviour was lost, the piece set itself nearly equatorially again, and the residual axial magnetism was either masked or lost. The reaction of induced currents naturally makes the examination of conducting masses rather troublesome.

During Christmas week Sir Wm. Thomson happened to pay the laboratory a hurried visit, and I showed him a piece of pitch-pine between the poles behaving exactly like a weak compass-needle; "a wooden magnet," as he at once called it. He was good enough to suggest a better mode of arranging the experiment for my original purpose of looking for the conversion of magnetism into diamagnetism: an arrangement which I have since adopted. So far, however, the results in this direction are very preliminary.

In all these experiments there is one flaw; and it is partly owing to this flaw that I have regarded them as unfit for publication. Indeed, I only send this note now because of the publication of Dr. Tumlirz's result. His experiment with quartz is very like one of mine, and it is very clearly and neatly described in his paper. But the same flaw, or what appeared to me to be such, seems to extend to his ca e also. What guarantee is there that no trace of iron is present,—perhaps as mere dirt, more likely as an infinitesimal ingredient of the substance? Several of the pieces of coke I used had been boiled for weeks in several lots of hydrochloric acid, and the last few washings gave no ferrocyanide coloration; but I have no doubt the coke yet contains iron. Possibly the other substances do too.

Suppose, now, a substance contains a trace of iron, which iron is susceptible of permanent magnetism, no matter how feeble: then, no matter whether the substance itself be paramagnetic or diamagnetic, in an intense field its own properties will altogether overpower those of the trace of iron, for this trace may be considered as magnetically saturated and done for at once. But suppose the substance next finds itself in a very weak field: the induced magnetism and the force depending on it, since they vary as the square of the field, are vanishing quantities; any trace of residual or permanent magnetism has it all its own way.

What way is there of proving that not a trace of iron exists in a body? Chemical tests are surely futile compared with the test of a magnet. I see at present no way out of the difficulty.

And would not the same difficulty recur in connection with my original notion? I believe it would. Suppose I succeeded in finding a substance, paramagnetic in a weak field, diamagnetic in a strong one; it would be open to any one to object that the paramagnetism was due to a trace of magnetic impurity: that this impurity, being intrinsically highly susceptible, causes all the observed action in a weak field, but that it soon becomes saturated as the field increases in strength, and that then its force is altogether overpowered by the main bulk of less susceptible substance, whose saturation-point, if existent at all, is miles higher up. This substance then regulates the behaviour of the body, and, according as it is diamagnetic or magnetic, the whole body behaves diamagnetically or magnetically.

Notwithstanding the prevision of this difficulty, I determined to try the experiments, not knowing what might come of them, and thinking that a body which could be made magnetic or diamagnetic at pleasure would be of some interest, however its behaviour might be explained. I even thought of artificially constructing such a body by incorporating a trace of iron in a lump of bismuth, or by using semi-purified commercial bismuth. I have not done this yet, however, and accordingly do not know if it be possible.

That which has come, so far, of these experiments, viz. the apparent existence of magnetic retentivity in all matter, is in itself not an improbable result; rather, one might say it is a probable one; and although it may be possible to explain it by a trace of iron impurity, it by no means follows that this disappointing sort of explanation is the correct one.

The singular fact which most strongly suggests the need for some such explanation is that diamagnetic bodies are capable of ordinary permanent magnetism. It is true that on the Weber-Ampère theory the specific molecular current of a diamagnetic substance need not be zero but may have a small positive value, which is easily destroyed and reversed by a powerful field, but which yet may endow the substance with magnetic properties in a weak field. But the worst of it is that I have never been able to detect any trace of paramagnetic property, in a diamagnetic substance, other than this permanent or residual polarity excited by immersion in a strong field.

The only suggestion I can make is the following.

Let the molecular channels in a diamagnetic substance be not wholly free from resistance, though their resistance must be very small; let induced currents be excited in these channels by immersion in a magnetic field, and let them have time to dissipate a little energy and begin to die away before the field is removed. On now destroying the field, the inverse induction will more than destroy the previously induced currents, and will leave a residue of opposite current in the molecules; the body will therefore behave as a weak magnet, until these residual currents die away.

I must examine more carefully the excitation and decay of the permanent magnetism with time. With wood it seems to be a question of hours.

These dissipation experiments are very important and should be seriously attempted in several directions with proper appliances and funds. Thus: gas molecules appear to be perfectly elastic, or rather their impact coefficient of restitution is supposed to be unity, but if a box of gas be shut up in infinitely adiabatic cotton-wool for a century, will it have gone colder?

Again, iron molecules are supposed to be infinitely conducting, and their Ampère currents seem permanent; but if the moment of a bar were measured from time to time against gravity, when a given current circulated in a given helix round it, would it be found that age impaired its strength?

Once more, bismuth is supposed to be diamagnetic by reason of its non-resisting channels; but suppose a piece of bismuth is left in a constant magnetic field for a year, will it have lost some of its diamagnetic property? and when taken out will it be found magnetic for a time?

It may be remarked that, whereas it is certain (on Ampère's theory) that iron molecules are almost infinitely conducting, we have no similar assurance for bismuth; it is even possible to surmise that a body may tend to become diamagnetic in proportion as it chokes off its own molecular currents, while magnetic bodies are such as retain them perennially without apparent loss. If such were the case, diamagnetism would sometimes improve with age.

I am, of course, aware that there is another, and merely differential, theory of diamagnetism, but this leaves magnetism itself wholly explained; whereas, directly the Ampère theory of magnetism is even provisionally accepted, the Pruth of infinite molecular conductivity is already crossed, and the Weber theory of diamagnetism follows as a natural and indeed inevitable consequence. OLIVER LODGE

University College, Liverpool, March 15

Dissociation and Contact-Action

IN a recent issue (NATURE, vol. xxxiii. pp. 350-51) you drew attention in your "Chemical Notes" to some recent researches of M. Konovaloff on "contact-actions," and to the suggestion made by him that "the dissociation (in the cases referred to) was a consequence of the contact-action of the solid body." On referring to the abstract of M. Konovaloff's paper in the *Journal* of the Chemical Society for January, 1886, I meet with the following:—"As an explanation of this contact-action phenomenon it is asked whether it is not possible that the bombardment of the molecules on the solid matter causes the kinetic energy of the molecules to be transformed in part into the internal work required for their decomposition."

Perhaps some of your correspondents will kindly furnish me with references to original memoirs (or other sources of information) in which I may find this question competently treated. The idea here put forward by M. Konovaloff is surely not new. It might be extended, as I conceive, to such cases as, for example, the combination of SO_2 and O_2 to form SO_3, the formation of ammonia from a mixture of NO and H_2 in the proportion of $5H_2 + 2NO$, the formation of NO from a mixture of NH_3 with an excess of O_2, in each case when the gaseous mixture is passed over heated platinum-sponge or platinised asbestos. For some years past this explanation of such contact-action phenomena has appeared to me much more reasonable than such explanations as are generally suggested. The high temperature required in such cases seems to point rather to something in common with the initial dissociation caused by the intense heat of the electric spark, when oxy-hydrogen gas is fired. In such cases as those referred to above the lesser intensity of the heat applied from without may easily be compensated by intra-molecular results of the increased energy with which the impact of individual molecules must take place at high temperatures, and the great extension of the heated solid surface exposed to their bombardment. Under this view (with which my pupils have been familiar for some years past) combination is brought about through the atoms of some of the molecules of the mixed gases being brought into the *quasi-nascent state*. A. IRVING

Wellington College, March 10

Variable Stars

IN NATURE for March 11 (p. 440) Dr. Mills, in criticising Prof. Seeliger's *collision hypothesis* of the blazing forth of *Nova*, advances a theory of his own as a presumably original and novel explanation of the phenomena of variable stars. It may be of interest, therefore, to point out that practically the same explanation was suggested in 1878 by Prof. R. Meldola in a paper published in the *Philosophical Magazine* for July of that year.

In this paper the author states: "It is conceivable that in certain cases the composition of a star's atmosphere may be such as to permit a considerable amount of cooling before any combination takes place among its constituents; under such circumstances a sudden catastrophe might mark the period of combination, and a star of feeble light would blaze forth suddenly, as occurred in 1866 to τ Coronæ Borealis. In other cases, again, it is possible that the composition of a star's atmosphere may be of such a nature as to lead to a state of periodically unstable chemical equilibrium; that is to say, during a certain period combination may be going on with the accompanying evolution of heat, till at length dissociation again begins to take place. In this manner the phenomena of many variable stars may perhaps be accounted for."

It will be seen that these hypotheses are essentially identical, although it would appear that Dr. Mills limits his explanation to the formation of polymerides (presumably of some primordial matter), these constituting our chemical "elements." I cannot see, however, that he has any reasons for excluding the formation of true compounds, or why he should consider a variable star as necessarily one that is engaged *only* in "making elements." This last process would, no doubt, be the first to take place on the hypothesis of cooling from a state of complete dissociation, but there would surely come a period when the more stable chemical "compounds" could exist, and their formation would also be attended by the evolution of heat and possibly of light also. JNO. CASTELL-EVANS

London, March 13

The Iridescent Clouds and their Height

COL. TENNANT is mistaken in supposing that the only peculiarity of the clouds which appeared in December 1884 and 1885 is in their being fringed with coloured spectra, though these were, I believe, much more vivid than those of ordinary clouds, as described by him; besides which, my impression was that the colours were more varied than is usually the case. Col. Tennant, with his experience, will be better able to say than I am whether there is generally as much blue in the clouds he describes as in those under discussion. I stated in my letter of Dec. 29 last (p. 199) that there was no special amount of blue in the clouds seen the previous day, but on the 31st there was a good deal. However, I do not insist on this as being any important difference; but, by referring to the numerous letters this year and last about the clouds, he will see there were several other characteristic points.

These clouds are not like any ordinary clouds; if they can be referred to any of the usual classes they are cirrus, but decidedly different from any cirrus we generally see. Their usually very smooth texture was striking, though some on December 28 (1885) had the ordinary appearance of rippling, but in most cases this was too slight to be visible without optical aid, even when the clouds were broken up into narrow wisps, and in such a position that no colour was produced there was still something in their appearance which struck me as different from ordinary clouds. The frequently rectangular shape was very singular also, though they had not always this form. I said I had not observed this shape in the clouds of December 28, but other observers noted it on that occasion (see pp. 219, 220), and on the 31st I saw many of the clouds with this outline. It is shown indistinctly and with the corners cut off in Mr. C. Davison's sketches (pp. 292, 293). The form is generally described in the letters you have published as rhomboidal, but this is an effect of perspective; no doubt if the clouds were seen overhead they would appear rectangular. Their great height, too, must have been unusual, though perhaps not greater than that of the singular coloured clouds seen last summer in Bavaria by myself and in this country by others, as described in NATURE, and which differed from the clouds I am now describing in some important particulars. One patch of cloud was observed both here and at Shields on December 28, and a calculation from a comparison of the position as seen from the two places gives its height as 23 miles; while making the utmost allowance that seems permitted for the roughness of the observations only reduces its elevation to 11 miles. That it was the same patch of cloud observed from both places is undoubted, for one observer of it (H. R. Procter) was travelling from Shields to Sunderland, and he saw that it was the same patch all the time, and the one I had been observing here. The fringes of colour were distinctly visible on this cloud up to 4h. 25m., and feebly so till 4h. 27⅔m. I concluded that the sun had not ceased shining upon it till that time; if so, its height would be between 11 and 12 miles. At 4h. 28⅓m. it was pink with sunset colouring; but the sun need not have been shining on it then.

The iridescent colours have no connection with halos, as supposed by Mr. Stone (p. 391), no particular colour appearing at any particular distance from the sun, but every colour being seen at any distance, though more vividly at perhaps from 15° to 30° off the sun. THOS. W. BACKHOUSE

Sunderland, March 12

Forms of Ice

A CURIOUS formation has lately occurred on the surface of a sheet of ice in a tub. Being under a tap, the ice became submerged below several inches of water. Fresh ice then formed as thin vertical plates upon, and at right angles to the submerged sheet. These plates meeting each other in all directions, produced a spongy mass, 3 or 4 inches thick. I do not know if it is a common production, but the special interest attached to it is that it would seem to suggest how "spongy" quartz has arisen, of which I have a specimen consisting of thin and nearly parallel plates; as well as the well-known form of thin crystalline plates in which calcite may occur. It is just this form of calcite which gives rise to "hacked" quartz, when silica has coagulated or crystallised over a mass of such thin crystals, and then these latter have been subsequently dissolved out.

Why a sheet of ice should increase regularly in thickness by additions to its lower surface, and form this spongy mass on its upper, is a question I should like to hear solved.

Another form of ice I lately noticed on a wall consisted of minute prisms standing in little depressions in the bricks. The circumference of the prism partook of the irregular form of the cavity, giving the appearance of an upward growth.

While speaking of ice, I should like to venture a suggestion to account for its lighter specific gravity than that of water, namely, that water crystallises in macles of complex form; the consequence being that the molecules cannot possibly fit together into a compact mass, as, for example, the rhombohedra of calcite do; for ice really resembles compact snow.

GEORGE HENSLOW

Sunrise-Glows

ON the morning of the 7th inst. a curious form of sunrise-glow was observed on Ben Nevis. The sky at the time was covered by a uniform thin sheet of stratus-cloud lying just a little above the hill-tops all round. About 7 a.m., shortly after sunrise, the sun was shining downwards through this cloud, and the valleys to the eastward of Ben Nevis were filled with a "glow" exactly similar in colour and general appearance to the upper glow so often observed before sunrise and after sunset. The temperature at the time was very low—9°.2 F.—and at 7.16 a portion of a vertical halo passing through the sun's disk was seen. This "under-glow" would seem therefore to have been due to the presence in the air of ice-crystals, rather than of dust, whether cosmic or otherwise.

R. T. OMOND

Ben Nevis Observatory, March 8

A Horrified Cat

LAST week, in connection with a study of Carnivora, I obtained a cat from an acquaintance at a distance, and carefully dissected it in a room above our stable. When I had finished, the cat was, as may be supposed, hardly to be recognised. I cleaned the scalpels, placed them in the case, and took them to the house. No sooner had I put them down than I observed our own cat go and sniff all around the case with a peculiar look of intense wonder. I took the instruments away, and thought no more about it; but a short time after I returned to the remains of the dissected cat in order to prepare the skeleton, when I saw our cat standing at a distance of about a foot from the dissection, and presenting an appearance of most helpless terror. She was trembling from head to foot, and in such a condition of evident horror that my presence had no effect upon her. After some moments she noticed me, and then darted away with a scared look such as I have never before seen. She did not return to the house that day—a thing quite unusual; but on the next day she returned and entered the house with a fearful caution, as though realising the probability that she herself might become a victim to science, and her whole conduct has changed.

This suggests that the country custom of using dead birds, weasels, &c., as a scare to the like is not entirely unreasonable, and it would be interesting to know whether others have noticed similar effects.

E. J. DUNGATE

Horton Kirby, Dartford, March 23

Nocturnal Hymenopteræ of the Genus *Bombus*

As no one has replied to Mr. Doria's letter in NATURE for February 25 (p. 392), I may say, in response to his inquiry, that I have heard in England a number of bees on a species of Tilia, at dusk, when it was probably much darker than the "very bright moonlight" referred to by Mr. Doria. It was too dark to watch them, but their "hum" was very audible, and on my dragging down a bough of the tree I saw one bee fly away. In Herman Müller's "Fertilisation of Flowers," English translation, p. 67, it is stated that a social wasp (*Apoica pallida*) in Brazil seeks honey "*only by night*," sitting still in its nest by day.

Query. Might not the "very bright moonlight," and not habit, be the cause of the bees appearing at night, as described by Mr. Doria? I should hardly think a bee could discern between moonlight and twilight. I have several times seen bees rapidly on the wing, and apparently making for home *in the twilight*.

JNO. C. WILSON

Fairfield, near Manchester, March 13

A LINGUISTIC REVOLUTION [1]

JAPAN, in modern days, is the land of revolution and of change. The systems and habits of centuries are rapidly disappearing; the old order is being dissolved by contact with the West, and every year produces some reform which brings the country more and more into line with Europe and America. There may sometimes be haste, but there is no rest, in Japanese movements; there is little swerving to the right or left, and now for about sixteen years the country has been, on the whole, steadily moving along towards one goal, viz. equality with Western nations, politically, socially, and intellectually. But of all the wonderful changes which the present generation has witnessed in that country, perhaps not one has been so strange or widely beneficial as that the commencement of which is described in the pamphlet before us. And as the first who will profit by it, should it prove ultimately successful, will be the rising generation which has to study Western science in all its branches, it deserves special description in these columns.

It will be known to many of our readers that the Japanese language, which, in its genius and structure, is wholly different from that of China, is nevertheless written by means of the Chinese ideographic or pictorial signs, aided by two alphabets or syllabaries, themselves based on Chinese characters. The object of the new movement, shortly stated, is to sweep away these signs altogether, so far as Japan is concerned, and to use Roman letters only in writing the language. The Association, which has been formed to carry out, as far as a private body can, this reform, has issued the present pamphlet by the advice of Her Majesty's Minister in Tokio, with the view of making known abroad a movement "which its authors believe to be an important step in the intellectual progress of their country." We cannot do better than follow this official statement of the evils of the present system, which is an incubus on the intellect of the nation, and which adds incalculably to the mental toil, more especially of its scientific youth, at the most important stage of their lives. It may be well, however, to say at the outset that the reform is no mere craze of a few misguided enthusiasts. The Society numbers amongst its most active and sympathetic members not only Japanese scholars of eminence who have studied their own as well as Western languages, but also Europeans and Americans who have devoted their lives to the study of the Japanese language and literature, and Western diplomatists who are most unlikely to participate in any visionary movement of this nature. When men drawn from these various classes, with the best means of studying the question on the spot, join together with the object of carrying the reform into practice, we, who have not the same opportunities of becoming acquainted with the local circumstances, may be excused from discussing its practicability any further. We may take that for granted, or we should not find the names supporting the reform that we do. Another point to be noticed is, that hitherto the Government has officially held aloof from the Association, preferring, no doubt, to allow private effort to prepare the soil beforehand. To return, however, to the pamphlet issued by the Society.

The object of the Romajie Kai, it states in the first sentence, is to introduce the use of Roman letters, instead of Chinese ideographs, for writing the Japanese language; when a language can be adequately represented to the eye by twenty-two signs indicating sounds, why (it asks) waste time and effort by continuing to represent it by many thousands of symbols pictorially representing objects and ideas? It is a labour of years to learn to write the Japanese language as at present written, viz. with Chinese characters supplemented by syllabaries invented by Japanese scholars a thousand years ago. The number of Chinese characters is not their only disadvantage. Upon their introduction (we here employ for the most part the exact words of the pamphlet) into Japan, it was early found impossible to restrict the employment of them to the expression of purely Japanese words of corresponding signification. The Chinese sounds, or, rather, a more or less inaccurate approximation to the Chinese

[1] "A Short Statement of the Aim and Method of the *Romajie Kai*" (Roman Alphabet Association of Japan). (Tokio, 1885.)

sounds, was imported gradually into the language of Japan along with the written symbols. It has therefore come to pass that, in Japanese books, one and the same character is at times used as the equivalent of a Japanese word, and at other times of the synonymous Chinese word. But, besides this source of confusion when the characters are used with their proper ideographic values, there is a further element of doubt and difficulty imported into written Japanese by the circumstance that many of the characters are occasionally employed as merely phonetic signs, irrespective of their meaning; sometimes to represent the mere sound of a Japanese word, at other times the mere sound of a Chinese word. Thus the difficulty of the ideographs arising from their numerical superabundance is aggravated by ambiguities in the modes of using them. Another disadvantage of the Chinese characters is the complexity of their form and structure. Although some scores of them are written with no more than three or four strokes of the pen each, there are thousands of others requiring each as many as ten, twenty, thirty, and sometimes even more than forty distinct movements of the hand for their formation. To write these complex combinations of lines, curves, and points always at full length was a task too much even for Chinese patience, and at least two distinct varieties of abbreviated handwriting came into general use both in China and Japan, namely, the "cursive" and the "grass" script. In most cases, however, these contracted forms of the characters are so destitute of any likeness to the original forms as to afford no aid whatever to the eye or to the mind in detecting their identity. To acquire the quicker modes of writing involves, therefore, a further considerable expenditure of time, and fresh demands upon the already over-burdened memory.

Nothing can be added to this clear and succinct account of the difficulties which lie at the threshold of knowledge in the Japanese language; but there is a serious aggravation of these difficulties, not referred to in the statement, when we come to the Western sciences, with the large and special vocabularies attached to most of them. If we take chemistry, for example, the Japanese student of this science is compelled to learn the translations into his own language of technical chemical terms and the Chinese characters which have been invented or adapted to represent these translations. Under the rational system proposed by the Society there is no reason why oxygen should not be written "oxygen" at once in Japanese, instead of by a couple or three fanciful symbols which may either be an attempt at translation or description, or an attempt to reproduce the sound, or arbitrarily selected to represent the word. The Japanese student would begin his work much where the English student does; he would learn the word "oxygen" once for all, and then learn its properties, combinations, &c., in the Japanese tongue, as the latter does in the English tongue.

The writers of the pamphlet then observe, with much force, that the excessive expenditure of mental power in learning by heart thousands of intricate symbols of sounds and ideas must diminish the stock available for use in other directions. The memory indeed is exercised, but at the expense of some of the other intellectual faculties. To this they are inclined to attribute in a large measure the comparative backwardness of the Chinese mind, and its deficiency in the powers of abstraction and generalisation—a very interesting observation which it would lead us too far to discuss now. Japan partially emancipated herself from the thraldom of the Chinese script when the syllabaries were invented a thousand years ago; but no complete deliverance is possible, they think, otherwise than by wholly discarding it in favour of a purely alphabetic system. So long as the literature of China formed the sole staple of education in Japan, little inconvenience arose from the multiplicity and intricacy of the Chinese ideographs, but now that European science is being eagerly studied and assimilated by the rising generation, the need of a simpler and easier script for the expression and propagation of the new ideas becomes every day more evident. The most convenient course is, clearly, to adopt the new terms as well as the new ideas bodily into the language, and this cannot properly be done unless the writing used be alphabetical. Amongst the subsidiary advantages of employing the alphabet in which the languages of the leading nations of the world are written is that the acquirement of any other European language will be much facilitated. Europeans, too, will find it much easier to learn the Japanese language when the principal stumbling-block is thus removed, so that, as the writers properly conclude, from both ends at once the channel of communication between Japan and the Western world will be widened and deepened by the employment in common of the Roman alphabet.

Very few words will suffice to explain the broad features of the scheme of transliteration produced after much consideration by a Committee of the Society, and now universally adopted. First, in using the Roman alphabet the consonants have been taken at their usual English values and the vowels at their values in Italian; secondly, the actual pronunciation of the words regardless of their spelling in the syllabaries, the latter in many cases being so totally different from the pronunciation that even Japanese themselves are frequently at a loss to write words in the syllabaries; and, thirdly, the standard of pronunciation chosen is that of educated people in the capital at the present day. Of the twenty-six letters of the Roman alphabet, four, viz. *l*, *q*, *v*, and *x*, are not used in writing Japanese, and are therefore omitted; in regard to capitals and punctuation the ordinary English method is followed. Nineteen rules, most of them too technical for special mention here, are laid down: they are all simple enough to those acquainted with the syllabaries, and can be readily applied in practice. Finally, the pamphlet gives examples of the various styles—literary, epistolary, &c.—in the present mode of writing, and under the Roman system according to the rules laid down.

Such being the objects to be attained and the method of attaining them, it is satisfactory to observe that almost universal assent has been given to the work of the Society. Some of the principal journals of the country set apart a certain portion of their space for articles printed in the Roman letters; a journal wholly printed in this way is published by the Society itself; the number of members is increasing by leaps and bounds, and many of the most learned and influential men in the country have already joined the ranks of the reformers. On the other side, of course, there are the rooted habits of a thousand years; but the Japanese have already succeeded in changing so many of their old habits and modes of thought that they may be trusted ultimately to succeed in this reform also. Moreover, it should not be forgotten that the present method of writing Japanese by means of Chinese ideographs is itself and imputation, a graft on Japanese civilisation, and, it may properly be urged, that what the nation has done once it may do again. The letters of the future may not be so artistic and beautiful as those of the present day; but this æsthetic objection will be counterbalanced by the fact that several years, at the most sensitive and valuable portion of life, will be added to the work of each generation, and a crushing obstacle will be removed from the gateways of knowledge for the Japanese youth of the future. Those who have technical and local knowledge speak of the perfect feasibility of the reform, and the outer world may accept their verdict with reasonable confidence; we may all, with a clear conscience, wish Japan success in one of the most arduous and beneficent reformations ever undertaken for a nation.

Since the above has been in type we have received the report of the annual general meeting of the Society, held in the great hall of the Engineering College of Tokio on January 23, amongst those present being some of the most prominent members of the Japanese Government, and many representatives of foreign Powers in Japan. The annual report stated that the Society now numbers over 6000 members, scattered over the various provinces of the Empire. A proposition having for its aim the retention of the old syllabary system of spelling, was rejected by a large majority in favour of phonetic simplicity, as above described. The Minister for Foreign Affairs, Count Inoue, delivered a speech, in which, viewing the aims, methods, and probable future of the Society from a great variety of standpoints, he expressed his complete sympathy with the movement. The British Envoy, in describing the objects of the Association, said:—"We aim at nothing less than one of the greatest changes ever yet made in the history of literature, or indeed, I may say, of the world. We hope to bring the thoughts of a nation of 37,000,000 into closer communion and intercourse with the thoughts of the rest of the world, and by freeing memory from the task of learning many thousands of characters, the sense of which can be satisfactorily rendered by a couple of dozen letters, to give the intellect some leisure to acquire the many and varied branches of learning which the necessities of modern civilisation render so important to us all."

THE SURVEY OF INDIA[1]

II.

IN our first notice we reviewed the principal topographical and cadastral operations. We have now to review the interesting information regarding the physiography of the localities of operation and other subjects which is scattered over the Report, but chiefly in the appendixes.

The Andaman Islands were being brought under survey for the first time; they form a portion of the belt of islands extending from the south-west point of the Burman mainland to the north-west point of the great Island of Sumatra, which are all that is now left of what was probably once a long, tapering off-shoot from the Asiatic continent, such as we still have in the Malayan Peninsula. These islands became of interest to the Government of India only of late years, when a convict settlement was established at Port Blair, on the South Andaman Island; but as yet little intercourse has been established with the inhabitants, who are wild and barbarous aboriginal Negritos with very dark skins and of very small stature. They are said to consist of nine distinct tribes known as Akas, which occupy separate islands and speak different dialects. Our influence has been most operative on the Aka-Bojigngiji, who are settled nearest Port Blair, and our relations with some of the other tribes are said to be on a fairly friendly footing, but very little is known about them, and nothing of the interior of the islands which they inhabit.

The Aka-Járawas, who occupy the Little Andaman, have ever been openly hostile; they are professional wreckers whom it has been necessary to punish on more than one occasion for barbarities perpetrated on shipwrecked crews, but they still retain their reputation for treachery and cruelty, and hold aloof from friendly intercourse; of late years they have been visited annually by the Chief Commissioner, and presents have been made to them with a view to bringing about more amicable relations, but they have been known to accept the proffered presents and then attack the bearers on their way back to their boats; their language is said to be unintelligible to the anglicised or tamed Andamanese, who are employed as a go-between. The Survey officers landed on the island and deposited presents on the beach, and then retired to their boats; the Járawas advanced and appropriated the presents somewhat sulkily and retired into their forests, and consequently nothing could be done with them; but their dwelling-places were entered and examined by the surveyors in their absence. These were found to be substantial, well-built huts, affording shelter for from 30 to 40 people, circular, dome-shaped, about 60 feet in diameter, and rising to a height of some 35 feet in the centre; the dome was thatched, and supported on long poles set up in three concentric circles within the hut. Small cots and a rocking-cradle were found inside; and all round the interior pigs' skulls, beautifully cleaned and neatly bound up, were closely arranged about three feet from the ground.

Barren Island (lat. 12° 15′ by long. 93° 50′) and the Island of Narcondam (13° 26′ by 94° 16′) were visited and surveyed by Capt. Hobday, whose exquisitely shaded maps of these interesting volcanic islands are published with his report. Barren Island is circular in shape with a diameter of 2 miles and an area of 3·07 square miles. Its principal features are a main crater and an inner cone. The main crater is elliptical in shape, with axes of 1½ and 1 mile, the walls rising to a height of 1158 feet above the sea-level on the south-east, and sinking down to the sea on the north-west; the cone is about half a mile in diameter at its base, and rises 1015 feet above the sea, terminating in a small elliptical crater, with axes of 300 and 190 feet and a maximum depth of 74 feet. Steam and smoke were issuing from the highest point of the cone; sulphur was found in large quantities near the vent, at a temperature sufficiently high to be felt through the boots. There was evidence of three distinct outbursts of lava on the sides of the cone, half-way up; the slopes were coated with fine volcanic ash, which made the ascent very laborious; loose cinders and scoriæ of various sizes lay heaped together in confused masses around the base, amid which occasional tongues of alluvial soil, overgrown with thick grass, were found jutting from the inner slopes of the main crater; the outer slopes were covered with thick vegetation, the principal tree being a species of fig. The island was infested with rats, which had not yet learnt to become shy of man, and were readily knocked over with sticks; bats and large crabs were found on the summit of the main crater. The outer slopes of the main crater would, if prolonged, meet in a point immediately above the present apex of the cone; thus it is conjectured that the crater was originally a true cone rising to about twice its present height, and that the upper portion has been carried away by a violent eruption, such as recently occurred at Krakatão, leaving the present truncated crater. The volcano is known to have been in an active state towards the end of the last century; since then it has been gradually cooling, and the temperature of a hot spring on the beach was found to be considerably less than it had been when measured by previous visitors.

The Island of Narcondam is about 2½ miles in length by 1¼ in breadth, and rises to a height of 2330 feet above the sea; it is composed of trachytic lava, but no trace of any crater was discerned. The slopes were covered with dense forest, but water was not found anywhere; flocks of hornbills or toucans, uttering a peculiarly shrill note, followed the surveyors on their way to and from the summit; and a large iguana, with long prehensile claws, was captured and sent to the Museum at Calcutta.

In Assam a raid of the semi-savage Akas who inhabit the hills on the borders of Tezpur and Lakhimpur, led to the acquisition of some new geography by Colonel Woodthorpe and a party of surveyors who accompanied the troops which were sent to recover the British subjects who had been captured by the Akas and carried away into their hills. The country of the Daphlas was crossed, when a river, never before heard of, the Kaneng, was discovered

[1] "General Report on the Operations of the Survey of India Department, administered under the Government of India during 1883-84." Prepared under the direction of Col. G. C. De Pree, S.C., Surveyor-General of India. Continued from p. 444.

and proved to be the most important of all the affluents of the Baroli; it drains much of the area which has hitherto been assigned to the Khru. Colonel Woodthorpe maintains that some confusion appears to have existed in the public mind as to the proper application of the names Abor and Daphla, for whereas it is believed that "the Daphlas always tattoo but the Abors never," just the reverse is the case. "Abor" is, however, a very vague appellative, and among the Assamese themselves means only a "foreigner." It is applied equally to tribes in the Aka, Daphla, Miri, Mishmi, and Naga Hills, and is only acknowledged by the so-called Abors themselves out of deference to the ignorance of those who, they believe, would fail to recognise them under any other name.

The survey of Independent Sikkim, in which Captain Harman's life was nobly sacrificed, has now been completed by his quondam assistant Mr. Robert. Returning from the northern frontiers of Sikkim, Mr. Robert has brought the unlooked-for intelligence that there are no great glaciers in the valleys to the north-east of Kinchinjinga, though situated on the shady side of peaks and ridges ascending as high as 28,000 feet, and nowhere under 20,000 feet; masses of glacial ice and *névé* skirt the lower slopes of the mountains, but without protruding into the valleys, and as a rule the enormous mass of snow deposited on these mountains—which are among the highest on the surface of the earth—is either evaporated where it falls or is melted and carried off by the Lachen and other feeders of the Teesta, without having first passed into the state of glaciers such as pervade the entire length of many of the valleys of the North-West Himalayas, near the junction with the Hindu Kush Range, where the mountains are lower, but the annual rainfall is much less.

The Survey operations confirm the general accuracy of the admirable sketch-map constructed by Sir Joseph Hooker upwards of thirty years previously, which has been our only reliable map of Sikkim up to the present time, and which still represents the limits of the geographical knowledge acquired by Europeans beyond the frontiers of Sikkim; the officers of the Survey have not been able to penetrate further north than he did, nor do more than see, as he saw, without fixing, the peaks of the great Tibetan ranges beyond; all new geography in Tibet is wholly due to the native explorers.

Colonel Tanner gives an interesting account of the journey of one of these explorers, "the Lama," through portions of Southern Tibet and the northern borders of Bhutan; an excellent map is attached in illustration. The Lama travelled round the entire circumference of the famous Yamdok Lake—lat. 20° by long. 90° 45'—which was visited by D'Anville in 1735 and by Manning in 1811, and forms such a prominent object in all maps of Tibet; he found it considerably larger than has hitherto been conjectured, the circumference being 120 miles excluding and 180 miles including the bends of the shore. There are numerous towns and villages on its banks, a large population, and much cultivation. It is sometimes called Piahte, or Pálti, after a neighbouring town, but most commonly the Yamdok-tso or Scorpion Lake, because its shape resembles that of a scorpion; the tail points eastwards towards the Kár-másing, "the starry plains," or "plains of heaven," a delightful and far-reaching extent of sward on which graze thousands of cattle, horses, and beasts of the chase; the two claws point to the west, and almost encircle a peninsular mountain tract, on which there are some villages and an important monastery. The south claw partially encircles an inner lake—the Dumu-tso—which is 500 feet higher than the main lake, and has a circumference of 24 miles, and is regarded by the Tibetans with great awe, fear, and superstition. There is an idea that some day Tibet is doomed to be flooded and all animal life destroyed by the overflow of this lake, and prayers are constantly being offered up in the surrounding monasteries to avert the catastrophe. Earthquakes, landslips, and convulsions, accompanied by subterraneous noises, are said to be of constant occurrence, and the waters are reputed to be steadily rising, notwithstanding the prayers constantly offered by the monks to turn away the wrath of the demon of Dumu-tso, who is believed to be confined below the waters.

The Yamdok Lake drains westwards into the Yarusanpo or Upper Brahmaputra River, through a valley which lies parallel to the river but slopes in the opposite direction. Colonel Tanner points out that this is a general feature in the drainage of Southern Tibet, all the principal feeders of the Sanpo running for the greater length of their courses in a contrary direction to the great river itself. The Lama was informed that the lake occasionally falls to so low a level that it receives water from the Sanpo, but this seems scarcely possible, for on the occasion of his visit it stood 1600 feet above the Sanpo at the point of junction with the drainage channel—as shown by his boiling-point observations—and even then the flow of the current in the channel was not particularly remarkable. It not unfrequently happens in analysing the work of the native explorers that the facts deducible from their own observations, which they are taught to make accurately but not to reduce, prove some of the tales they have been told by the people of the country to be fictions.

To the south of the Yamdok the Lama discovered a new lake, called the Pho-mo-chang-thang (*lit.* man and wife of the high plain), at a height exceeding 16,000 feet, embosomed in lofty mountains and having no outlet. The range to its south is a portion of the great water-parting between India and Tibet; the Lama crossed it by the Menda Pass, 17,450 feet high, and then descended the north-west branch of the Lhobra River to Lhá-kháng Jong (lat. 28° 5', long. 91° 5', height 9500 feet), where he saw the Lhobra River flowing to the south towards Bhutan through a deep gorge. Colonel Tanner says this river must be one of the largest, if not the very largest, feeder of the Monas, but we know so little of Bhutan that it is hard to say which of the streams crossed lower down by Pemberton is the Lhobra. Leaving Lhá-kháng Jong the Lama ascended the north-east branch of the Lhobra River, and again crossing the great water-parting—at the Sharkha-leb Pass, 16,800 feet—returned to Tibet, his *détour* to the south having taken him over much ground that was entirely new to geography. Our limits do not allow us to devote more space to his travels, which are very interesting and valuable,—a satisfactory evidence of the advantages which the Indian Survey derives from its utilisation of Asiatic *employés* to explore regions into which Europeans are not allowed to penetrate.

Colonel Tanner is an artist as well as a geographer, and his reports contain much picturesque description, in addition to necessarily dry detail. He was employed for some years in the Western Himalayas, around Gilgit, and in the neighbourhood of several very high mountains, including the great Nanga Parbat and the sharp-pinnacled Rakiposhi; and he gives an interesting comparison of the aspects of these mountains with those of the Eastern Himalayas, showing that the latter are less striking, though they are the higher, and include Everest, 29,000 feet, the highest peak yet measured on the surface of the globe; their bases are more elevated, and thus the surfaces of snow which they expose to view rise into the sky to a less height above their surroundings. He says of Everest that the outline is rather tame than otherwise, and that Makalu—27,890 feet high, and 12 miles south-east of Everest—is the finest peak yet fixed in the Eastern Himalayas, with the exception of Kinchinjinga, 28,160 feet. The fact is that Everest lies some distance to the north of the main line of peaks, and the view of it from the south-east, south, south-west, and west-south-west is shut out by more prominent peaks which, though lower in height, are nearer the point of view accessible to Europeans, and are also less lowered by the earth's curvature than the more distant pinnacle. These peaks are frequently mistaken for Everest; thus in the atlas accompanying the "Results of a Scientific Mission to India and High Asia" there is a large chromolithographed plate from a drawing by Hermann Schlagintweit of a mountain which he believed to be Everest; but the mountain is undoubtedly Makalu, as has recently been pointed out elsewhere.[1] The best view of Everest from British territory is obtained at Sandakphu, a well-known hill on the boundary between Nepal and Darjeeling; but even there it is partly shut out from view by Makalu, which being exceedingly bold and picturesque in appearance generally comes in for more attention than its higher neighbour.

The pillars and posts marking the line of boundary between the Nepalese and the British territories, having in many instances been destroyed by wild animals or carried away by floods, survey operations have been undertaken, at the request of the Nepalese Government, with a view to relaying the line. This has afforded an opportunity of surveying the Sameswar Hills, the water-parting of which constitutes a portion of the boundary. A strip of the Nepalese territory which skirts the boundary has been sketched as far as circumstances would permit, and large errors in the topography of the tract, as laid down hitherto from native information, have been discovered and corrected. The Sameswar Hills are said to be very similar to the Siwalik Ranges, which the palæontological discoveries of Falconer, Cantley, and Baker have made so famous, excepting that the peaks are generally of less altitude, and the *Pinus longifolia* is almost entirely absent.

Major Holdich gives an account of the first ascent ever made by Europeans of the famous Takht-i-Suliman, or Throne of Solomon, the highest portion of the range of mountains on the western border of the valley of the Indus, which separates the highlands of South-Eastern Afghanistan from the plains of the Punjab. Viewed from these plains the Takht has the appearance of a ridge some 8 miles in length, much elevated above its surroundings, and with two culminating peaks at its northern and southern extremities,—apparently admirable points from whence to make a survey of the tract of country extending westwards almost as far as Candahar and Ghazni, of which very little is known. Lieutenant James Broadfoot, of the Bengal Engineers, travelled across it in 1839, by the route from Ghazni to Deva Ismail Khan *viâ* the Ghwaleri Pass, of which he made a hurried sketch under great difficulties; and the Zhob Valley to the south has been roughly mapped by a native explorer. But much more knowledge of the country was wanted, and this it was expected might be obtained by observations from the two great peaks of the Takht, the ascent of which had for many years been an object of laudable ambition on the part of the Survey officers; they were greatly gratified when the Government authorised a survey expedition to be sent to the summit of the mountain, with a sufficient escort of troops to overcome any possible opposition. On reaching the summit the Takht was found to consist, not of a single ridge, but of two parallel ridges, with a plateau between, the highest point at the northern extremity (11,300 feet) being on the western ridge, while that on the southern extremity (11,070 feet) is on the eastern ridge, and is unfortunately shut out by the other from all view of Afghanistan. Thus the Takht was disappointing as a basis for distant geographical exploration; but a good deal of valuable topography was secured of an important but little-known portion of the Sulimani Range, which constitutes the primary base for the defence of India from western aggression.

In Biluchistan Lieutenant the Honourable M. G. Talbot, R.E., and Lieutenant Wahab, R.E., made a valuable reconnaissance to the south-west of the little-known region which lies between Kelat, the capital, and the town of Gwadur, on the Persian Gulf; they worked over the Raskoh Ranges across the great plain of Kharan to the Lagar Koh and Koh-i-Sabz Ranges, and down to Panjgur. Much of the country traversed was a desert, and the scope of the operations had to be carefully adjusted to the limited available supplies of both food and water for men and animals.

The systematic tidal observations with self-registering tide-gauges, which were instituted under the superintendence of Major Baird, R.E., F.R.S., by the Government of India, in accordance with the recommendations of the British Association, have been continued at sixteen stations —including the ports of Aden, Kurrachee, Bombay, Madras, Calcutta and Rangoon, and Port Blair—completed at two stations, Kárwár and Pámban, and commenced at three new stations, of which two are on the Island of Ceylon, more under the direct influence of the Indian Ocean than the stations on the coasts of India. Good progress has been made with the lines of spirit-levels which are carried between the tidal stations, both along the coast lines and across the peninsula from coast to coast. So far as yet completed the operations indicate that the mean sea-level may be regarded as practically identical at all points on the open coast.

The Calcutta International Exhibition has necessitated a considerable extension of the operations of the lithographic and photographic offices under Colonel Waterhouse; the processes of heliogravure and collotype were found very serviceable in reproducing the delicate objects of Indian art-work which were exhibited. In the first of these processes a valuable improvement has been effected; originally the engraved copper plate was obtained by developing a positive pigment print, or relief in hardened gelatine, on a silvered copper plate, and then depositing copper upon it so as to form a new copper plate, bearing the design in intaglio, from which prints can be taken in the usual way. In the new process a *negative* pigment print is developed on a copper plate, and the intaglio image is obtained directly on the plate by biting in with a chemical solution, which penetrates the gelatine film comparatively easily in those parts representing the shadows of a picture or lines of a map, where there is little or no gelatine, biting the copper to a considerable depth; whereas in the parts representing the light of the picture or the ground of the map, where the gelatine is thicker, it penetrates with more and more difficulty as the thickness of the gelatine increases, and in the highest lights should leave the copper untouched. The operation of biting does not take more than five minutes, and the engraved images are said to be marvellous in their delicacy of gradation and richness of effect. The great advantage of the process is its rapidity, a day or two being sufficient to prepare the etched plate, whereas from three weeks to a month are required to "deposit" a printing plate of sufficient thickness by photo-electrotyping; on the other hand, it is difficult to get etching of sufficient depth to stand much printing without the loss of the finest tints.

The Report contains many other items of interest which our limits do not allow us to notice. It has evidently been compiled with much care, though there are occasional slips, as at page 3, where the country of Kafiristan is referred to as "an explorer in the service of the Educational Department," and the scale of the survey of that country is said to be "confidential." J. T. W.

[1] See "Notes on Mount Everest" in the *Proceedings* of the Royal Geographical Society for February 1886.

SCIENCE SCHOOLS AT HOME AND ABROAD

IN this volume Mr. Robins has collected together a series of communications which have appeared at various times in the *Journal* of the Society of Arts and

[1] "Papers on Technical Education, Applied Science Buildings, Fittings, and Sanitation." By Edward Cookwortny Robins. (London, 1886.)

in the *Transactions* of the Royal Institute of British Architects. The republication of these papers coming so soon after the last Report of the Commission on Technical Education is most opportune. We have here, brought as it were to a focus, a mass of detail relative to the planning, construction, and mode of equipment of the most noteworthy schools of science of Europe. To the teacher of applied science, and especially also to the many bodies of public-spirited men who are engaged both in London and in our midland and northern towns in the erection of buildings for applied science and art instruction, the work must be in the highest degree valuable. The mere collection of the facts themselves could not fail to prove of the greatest service to the cause of technical education in this country; but when the facts are, as it happens, arranged, co-ordinated, and criticised by one who has himself had no inconsiderable experience in designing buildings of this class, the collection becomes simply indispensable.

In the first paper, on "English and Foreign Technical Education," Mr. Robins seeks as it were to clear the ground. In this matter, as in so many others, it is the houses which obscure the view of the village. Mr. Robins therefore attempts to state precisely what it is that technical education aims at, and how we may reasonably hope that the aim may be attained. It is of course only after the lines have been laid down upon which the teaching of technology should proceed that the question of appliances and buildings can be properly approached. It is necessary therefore to carefully analyse the results which have been obtained abroad, for we have at present little to appeal to at home, and even that little has been too recently in operation to afford a basis for sound conclusions. We have as yet no system. That is, of course, characteristic of us, for we are continually reminded that we are, in some respects, the most illogical people in the world. Nothing in our whole educational history is more characteristic of us—of our energy, public spirit, and independence—than the way in which with much effort, laborious and occasionally ill-directed, and with no inconsiderable expenditure of money, we are hammering away at this question of teaching technology. In Yorkshire alone there is at the present moment probably every type of technical school more or less imperfectly developed, which the ingenuity or perversity of man could devise,—from the school which does nothing but handicraft pure and simple, up to that which concerns itself mainly with the science of practice, and relegates practice itself to the workshop. The men who are struggling with this problem of grafting a high-class scientific education upon the daily work of our towns are the manufacturers, the engineers, and merchants of our great commercial centres. These men —the men who build the big bridges, bore the big tunnels, sink the deepest mines, set up the highest blast-furnaces, and gauge their power for civilisation, as Liebig said, by the size of their vitriol chambers—have a silent horror and tolerant contempt for *doctrinaires*. Mr. Froude may say of the age of patriotism—as Burke said of the age of chivalry—that it is dead. But England owes a debt of gratitude to those who are thus struggling to keep her in the forefront of the battle for industrial supremacy among the great producing peoples of the world, and who are unstintingly spending time, energy, and money in the determination that their sons and the generations to come shall reap some of the benefits of knowledge that were denied to them.

In Mr. Robins's first paper, published in 1882, there is much relative to the Continental systems which has been supplemented by the Report of the Commission, but regarding it simply as introductory to the purely professional papers which constitute the most valuable feature of the book, it would be necessary to modify it in but few and comparatively unessential details.

In the next paper, on "Buildings for Applied Science and Art Instruction," Mr. Robins gives a detailed account, mainly compiled from personal visits, of the most distinctly representative buildings of this class to be met with in Germany, Austria, Sweden, and in our own country. In this paper we have the first attempt to formulate the general principles which should govern the planning of buildings intended for technical instruction. All technical education does not need special accommodation. Mr. Robins points out that the ordinary class-rooms attached to school-buildings may be appropriated to certain kinds of technical instruction provided that they are properly lighted and ventilated. But there are many subjects which can only be efficiently taught in specially-designed buildings, as, for example, chemistry and physics, mechanics and engineering, architecture, &c.,—in fact, all involving the provision of laboratories, lecture-theatres, work-rooms, modelling-rooms, &c., which have to be grouped in a certain order and contiguity, and which must be specially floored, lighted, heated, and ventilated, and arranged for particular furniture and fittings or special apparatus. It is with buildings of this class that we are at present more particularly concerned.

In Germany, and in the German-speaking part of Europe generally, the system of working the different subjects in separate buildings is now almost universally regarded as the most convenient arrangement. Thus at Berlin, Prof. Helmholtz's physical laboratory and its associated class-rooms and lecture-rooms are in one grand building, and Prof. Du Bois-Reymond's physiological laboratory is in an adjoining building—worthy companions of the handsome structure erected for Prof. Hofmann so long ago as 1865. At Leipzig is a street full of separate and distinct buildings for these subjects, supplementing the old University provisions. At Geneva, Prof. Graebe has designed and superintended the general arrangement and fittings of the new chemical laboratory, also situated apart from the University proper. Profs. von Pebal and Toepler at Gratz, Prof. Landolt at Aachen and Berlin, Prof. Baeyer at Munich, have each worked out, with the respective architects, the details of their new and remarkably well-fitted laboratories. At Strasburg the new University buildings are also constructed in separate blocks. In addition to the main building for classical studies and general literature, distinct blocks are arranged for physics, chemistry, botany and forestry, mineralogy, &c., each block costing from 30,000*l.* to 40,000*l.*, built in the classic style, faced with stone from the Harz Mountains, and together covering several acres of ground.

In addition to these Mr. Robins adds, as types of less ambitious places, an account of the chemical and physical laboratories of the Royal Trade School at Chemnitz, of Prof. Kohlrausch's physical laboratory at Wurzburg, of the Technical High School at Hanover, of the Royal Technical High School at Stockholm, and of the Chalmers Industrial and Technological School at Gottenborg.

It would be quite impossible, with the space at our disposal, to attempt to follow Mr. Robins in his analysis of the distinctive features of these various institutions. He has treated the mass of material thus brought together in a remarkably clear and lucid manner. There is necessarily much in every chemical laboratory which is common to all, and the same remark applies to every other laboratory or workshop in which technology is taught. Nothing more certainly indicates the trained professional eye than the manner in which characteristic differences are detected and commented upon, and it is the evidence of this diagnostic faculty which constitutes one of the most valuable features of the book.

But perhaps the most generally interesting portion of Mr. Robins's work is that relating to the applied science buildings which have been erected in this country. These consist of the Central Technical Institution at South Kensington and the Technical College at Finsbury, both erected by the City and Guilds of London; the Owens

TECHNICAL COLLEGE, FINSBURY

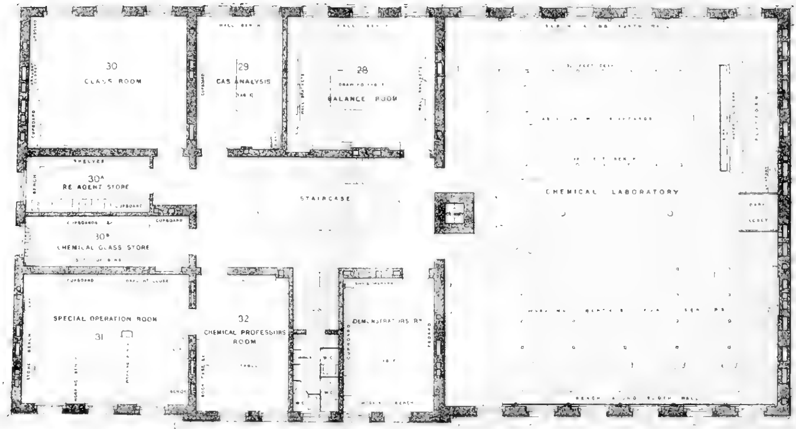
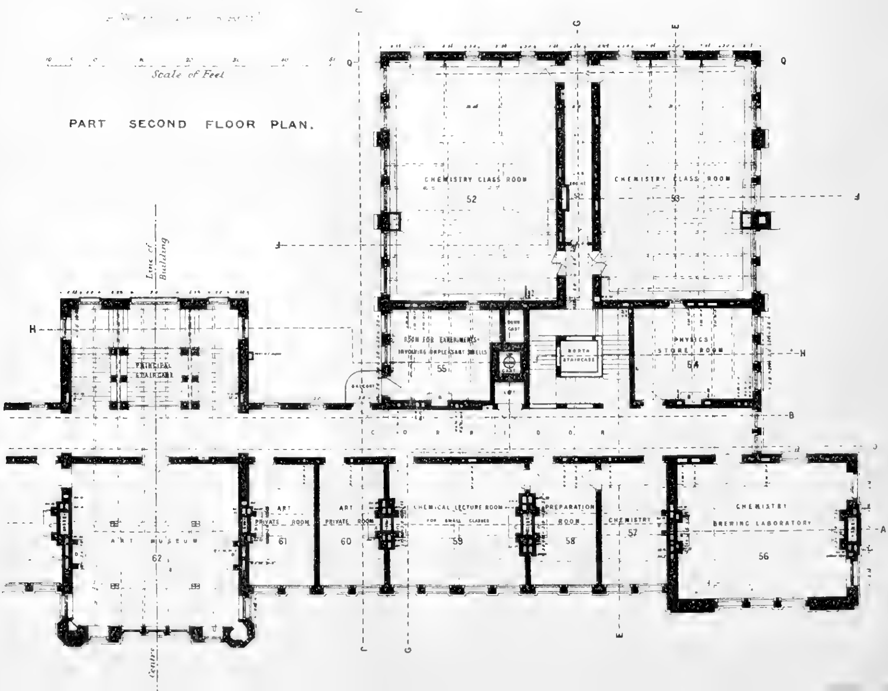


FIG. 18 SECOND FLOOR PLAN

THE CITY AND GUILDS OF LONDON CENTRAL TECHNICAL INSTITUTION, SOUTH KENSINGTON, LONDON

Scale of Feet

PART SECOND FLOOR PLAN.



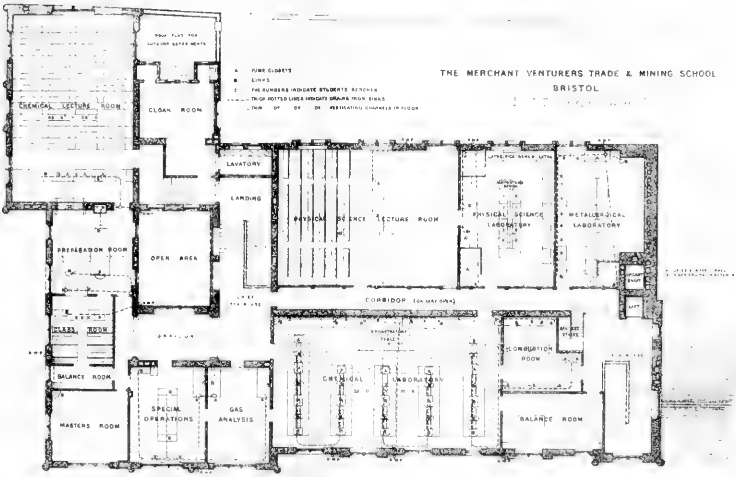
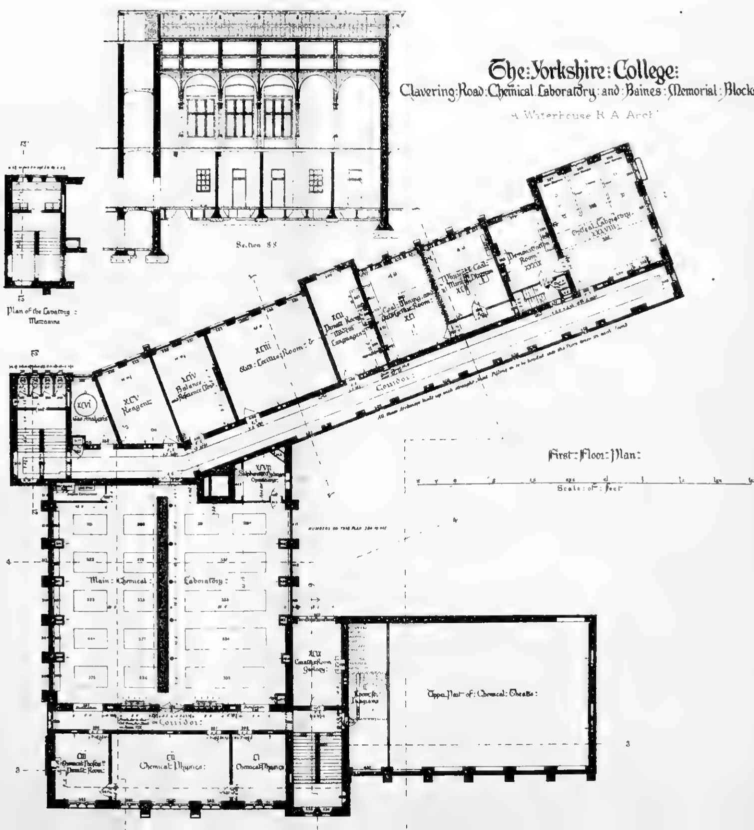


FIG 1 TOP-MOST FLOOR



College, Manchester; the Yorkshire College, Leeds; University College, London; the Mason College, Birmingham; and the Merchant Venturers' School at Bristol. As a typical school laboratory Mr. Robins has very judiciously chosen that of the Manchester Grammar School. We have selected for reproduction here, from among the many sheets of plans with which Mr. Robins's papers are illustrated, portions of the plans of the Central Institute, the Yorkshire College (Leeds), and the laboratories of the Merchant Venturers' School at Bristol, as types of institutions engaged in the work of teaching how science is to be brought to bear upon the industries of this country. In the Merchant Venturers' School we have a building specially constructed for teaching science to large classes of boys; in the Yorkshire College the arrangements, as regards science, were designed with reference to the requirements of students receiving specialised teaching, and who intend to pass into manufactories or workshops, or to become professional chemists, physicists, or engineers; in the Central Institute we have the most highly developed type, designed for selected students coming from the Finsbury College or from the provincial colleges, and who already have a basis of sound scientific knowledge, and are thereby fitted to receive special and advanced instruction in various branches of technology. A careful comparison of the plans of Mr. Waterhouse's buildings, viz. the Yorkshire College and the Central Institute, with that of Mr. Robins erected for the Merchant Venturers, will serve to show how the particular requirements of each class have been met in the case of chemistry. It will be seen that the number and relative size of the various rooms, their mutual position, and internal arrangement of work-tables, &c., are very different in the several buildings, and that these differences are primarily dependent upon the special type of instruction which is contemplated.

In the next paper Mr. Robins deals with the fittings for applied science instruction buildings. Strictly speaking, the two questions of fittings and structure cannot be considered apart, for, as Mr. Robins very truly remarks, "it is of the utmost importance in a truly economic aspect of the question that the architect should possess from the very outset a clear preconception of the structural provisions involved in the particular system of fittings intended." The paper has especial reference to the fittings of chemical and mechanical laboratories; it is singularly full and complete, and admirably illustrated. The fittings of every laboratory of note have been well studied, and the facts are so detailed that the merits of any particular arrangement can be readily determined. It is certain to be of the greatest service to any architect engaged in the erection of this special kind of building.

The last paper which we have space to notice deals with the important question of the heating and ventilation necessary for applied science instruction buildings. It is principally based upon details of the means adopted in four of the most modern erections in this country, viz. the Finsbury Technical College, the Central Institute (South Kensington), the Yorkshire College, and the Merchant Venturers' School. These buildings are characterised by very wide differences in compactness and in the relative proportions of inside and outside walls; and the particular modes of heating, that is, whether by steam or hot water, are also different. In some of the buildings the vitiated air is extracted by a chimney, or by a fan; in others the fresh air is forced into the buildings by a fan. Each system has its merits and defects, and most of these are pointed out in the paper, or in the appendix containing the remarks made during the discussion which followed the reading of Mr. Robins's paper at the Institute of British Architects.

It will be seen therefore that Mr. Robins has treated this question of the provision of buildings for applied science instruction in a remarkably comprehensive manner. The collection of papers is certain to be of the greatest service to any architects engaged in the erection of buildings of this class; it constitutes, indeed, a sort of *vade mecum* to the building committees who may be responsible for the selection of the architect's plans. The cause of technical education in this country is under a debt of gratitude to Mr. Robins for the service which he has thus rendered to it.

T. E. THORPE

JULES JAMIN

A SHORT time ago we announced the death of the eminent French physicist, Prof. Jamin.

By the courtesy of the editor of *La Nature* we are enabled this week to give an excellent portrait, to which we add a brief sketch of his scientific career, for the details of which we are indebted to the same source.

Jamin was born, in 1818, in the village of Termes in the Ardennes. He was the son of Anthony Peter Jamin,

who engaged as a volunteer in 1795, was appointed Captain and decorated at the battle of Friedland, and afterwards retired to his native country. Jamin was brought up first in a little school in the village of Vouziers, and his father sent him to the College at Reims.

At the end of the first year there Jamin had gained nine prizes, and in 1838 his work was crowned with the prize of honour in a general competition between the Colleges of Paris and the Departments. In the same year he entered the École Normale Supérieure, and three years after, in 1841, he came out first prizeman in physical science. He was then appointed to the College at Caen, where he succeeded Desains, whom he found later as colleague at the Sorbonne, and survived only a few months. At the end of two years he was called to Paris as Professor of Physics at the Collège Bourbon. The following year, in 1844, he became Professor at the College of Louis-le-Grand, where he continued his researches commenced at Caen, and he received in 1847 his Doctorate of Physical Science for a thesis, now a classic, on the reflection of light on the surface of metals.

The precision, elegance, and solidity of his instruction, the value of his scientific work, all designated him for some superior professorship; so, in 1852, he was elected Professor of Physics at the Polytechnic School. He lectured there with success for twenty-nine years—till 1881, when he resigned.

In 1863 he was appointed Professor at the Sorbonne, where, till his death, he attracted a great number of eager listeners. In this position he displayed his admirable talent of exposition, his great power of simplifying the most difficult questions, and of indicating by most striking apparatus the methods of solving many intricate problems.

The qualifications that Jamin displayed in his oral teaching are found in the "Traité Général de Physique," which reproduces his course at the Polytechnic School, and in which masters as well as pupils find exact descriptions of the actual state of science.

Jamin was not only a physicist; his mind was open to all manifestations of intelligence. At the Normal School, in preparing for his degree in physics, he found time to obtain one in natural sciences also. At Caen he went with his pupils on Sundays on botanical and geological excursions. But it was only on his return to Paris that his great power, elevated ideas, distinguished tastes and his fine intelligence could find a free scope. He remembered always with pleasure how at the age of twenty-five he found himself at once surrounded by an intelligent and enlightened society. He dined in a *pension* with several of his colleagues, who have left names either in science or at the University: with Lefebvre, the eminent professor at the Collège Rollin, with Saisset, Barni, Suchet, La Provostaye; with Faurie, who often brought his friend Sturm. The dinner was followed by long chats, dissertations on science, philosophy, music and art, in which Jamin took an active part. He loved music; he was a painter. He was an early riser, and on Sundays he went with one or two of his colleagues to study the works of the great masters at the Louvre. He painted an admirable portrait of Lefebvre; his family preserve several of his paintings, and the church at Termes possesses a picture of his composition.

But art and literature only occupied his leisure; he produced at that period his most important scientific works—works which procured for him in 1868 admission into the Academy of Sciences.

His researches embrace the most varied subjects. Besides his optical, magnetic, and electrical researches, which remain his best titles to fame, his studies on the compressibility of liquids, on capillarity, hygrometry, specific heats, the critical points of gases, prove the originality and versatility of his genius.

By their historical order and succession his memoirs indicate the progress of physics in France since the middle of the century to the present day. A pupil and admirer of Cauchy, it was by his optical experiments that he made his debut, and it was also to this subject that he most frequently returned.

He took great pains to invent methods of measurement delicate enough to control the analytical results of Cauchy, and his first memoir is a beautiful study of reflection of light by the surfaces of metals. He discovered afterwards the elliptical polarisation of light reflected by vitreous substances near the polarising angle, anticipated by Cauchy's theory; and discovered at the same time the negative elliptical polarisation of fluorine, which no one suspected. He published a long memoir on coloured rings, and invented interference-apparatus utilising the light reflected on opposed faces of thick transparent plates.

When in 1868 M. Durny, then Minister of Public Instruction, founded the École Practique des Hautes Études, and endowed a research laboratory, Jamin profited by the powerful aid thus placed at his disposal. The rapid and so unlooked for progress in electricity supplied a new field for his activity. Assisted at first by inexperienced workers, he thought, and worked for all; he undertook ten different researches, of which one would have absorbed all the time and power of one less indefatigable.

Cruelly touched by family affliction, he found in the midst of his workers, who needed continually his aid and assistance, some relief for his great grief. During some time before his death he seemed to have mastered his sorrows and to have regained his usual activity. He had succeeded his illustrious master, M. Dumas, as Perpetual Secretary of the Academy of Sciences, and no one was more fitted to have filled this delicate office. He had replaced Milne Edwards as Dean of the Faculty of Sciences, and at the time of his death he was at the height of his reputation.

His death leaves a large gap in Parisian scientific society, and those English men of science who had the privilege of knowing him and admiring his genial and powerful nature and his admirable private life will long mourn his loss.

R.

THE U.S. NAVAL OBSERVATORY[1]

IN 1880 a site was purchased for a new Naval Observatory a short distance beyond Georgetown, in the district of Columbia; but no appropriation has yet been made for erecting the necessary buildings and removing the instruments from the present location. On account of this delay the Secretary of the Navy, in April 1885, called upon the National Academy of Sciences for an expression of opinion as to the advisability of proceeding promptly with the erection of a new Naval Observatory; and the reply of the Committee of the Academy is contained at length in a letter from the Secretary of the Navy, just published as Executive Document No. 67. The conclusions of the Committee we give in the language of the Report. This Report is signed by F. A. P. Barnard, A. Graham Bell, J. D. Dana, S. P. Langley, Theodore Lyman, E. C. Pickering, C. A. Young. (1) It is advisable to proceed promptly with the erection of a new Observatory upon the site purchased in 1880 for this purpose. (2) It is advisable that the Observatory so erected shall be, and shall be styled, as the present Observatory was styled originally, the "National Observatory of the United States," and that it shall be under civilian administration. (3) It is advisable that the instruments in the present Observatory, with the exception of the 26-inch telescope, the transit circles, and the prime vertical transit, shall be transferred to the Observatory at Annapolis, with such members of the astronomical staff as may be required to operate them; also that such books of the library as relate chiefly to navigation shall take the same destination; the instruments above particularly specified, with the remainder of the library, being reserved as part of the equipment of the new National Observatory, to which also the remaining officers of the astronomical staff shall be assigned for duty. (4) It is advisable that the Observatory at Annapolis shall be enlarged, if necessary, and adapted to subserve as effectually as possible the wants of the Naval Service, whether practical, scientific, or educational; that it shall be under the direction of the department of the Navy, and shall be styled the "Naval Observatory of the United States." The grounds upon which this decision is based are set forth in the document to which we have referred; and numerous letters are appended, from astronomers and others, in regard to the administration of the Observatory, and from physicians of Washington, upon the healthfulness of the portion of the city in which the Observatory is at present situated. It will be seen immediately that this report is intended to favour the establishment of an Observatory worthy of the country, and the

[1] From *Science*.

placing its control in the hands of those who have made astronomy their life-work. The Navy will be provided, if the recommendations are carried out, with an Observatory well suited to its special needs, and would be relieved from the task of supervising work in which it has no interest aside from that felt in scientific work in general.

NOTES

WE learn with much regret of the death of Dr. Spencer Cobbold, F.R.S., the well-known authority on parasites and parasitic diseases, at the age of fifty-seven years.

WE understand that it is proposed to award the Founder's Medal of the Royal Geographical Society to Major Greely, the leader of the late United States Arctic Expedition to Grinnell Land, and the Patron's Medal to Cavaliere Guido Cora, Professor of Geography at the University of Turin, and founder and conductor of the geographical journal known as *Cosmos*. The Back Grant will probably go to Sergeant Brainard, who did such admirable work on the Greely Expedition.

MR. J. Y. BUCHANAN, who is in charge of the *Buccaneer*, telegraph surveying ship for the India-rubber Construction Company, writes home from St. Thomas, under date February 1, giving some account of his doings up to that time. When the survey to Loanda was completed, Mr. Buchanan was to be free to take any soundings he pleased and any route he pleased through the Atlantic, so long as he is home by the beginning of April. He has reached Loanda and visited Ascension, and expected to be at the Azores on the 24th. The following was to be Mr. Buchanan's programme after leaving Loanda:—"Stop at 6 a.m. Sound, then take temperatures, water-bottles, tow-net, and possibly dredge. This will take till noon, or perhaps longer; then on again. Next day stop and sound at noon, and take any observations which can be made during the sounding. This may detain us two hours; then on again, and next morning stop at 6 a.m., and make a station again. In this way the time divides itself into periods of 48 hours. Say from 4 p.m., when we set on after finishing a station, we run till 11 a.m. next day; this is 19 hours, or 200 miles; then stop 2 hours; then on again till 6 a.m. of next day, making 17 hours, or 175 miles; then stop till 4 p.m. In this way we get 36 hours' steaming and 12 hours' work in the 48, and cover 375 miles." "We have got very interesting results so far," he goes on, "and a perfect plethora of material. We made a most delightful excursion yesterday," he continues, "to a cinchona plantation up in the high ground in the interior of this island (St. Thomas). They grow very good coffee, and there is no leaf-disease, and they are planting everything up with cacao, which at present prices pays enormously. The island lies only twenty miles north of the equator, and both St. Thomas and Principe are perfect examples of the luxuriance of equatorial vegetation. In Principe the jungle is more dense; in St. Thomas the trees are on a larger scale, and there is magnificent timber. With the exception of Accra and Gaboon, these two islands are the only places where we have landed. All along the so-called *West* Coast the surf is at all times bad and frequently dangerous, so that communication is only kept up by native surf-boats, and Europeans pass through it as rarely as possible. . . . The African rivers are quite stupendous, and have much to do in giving the Gulf of Guinea its peculiar character. The drainage of quite 90 per cent. of the whole continent empties itself into a very restricted area of the sea, the formation and the conditions of which it has profoundly modified."

THE Colonial and Indian Exhibition, which opens in May, besides its wide general interest, will evidently have many points of special interest to men of science. The flora and fauna of almost all the colonies will be represented more or less completely. Thus, Mrs. Blake, the wife of the Governor of the Bahamas, has sent a series of beautiful paintings of the flora of that archipelago for the West Indian section; British Guiana sends specimens of all its woods, to the number of 74. Each block is about 3½ inches wide, 15 inches long, and 3 inches deep. The several pieces are labelled with the colonial name of the wood, its botanical name wherever possible, the height to which the tree grows, and its use. Dr. Schomburgk, the Director of the Botanic Gardens of South Australia, is sending a very comprehensive dried collection of the flora of that colony. It consists of four volumes, and contains 1100 different specimens. A similar collection was sent to the last French Exhibition, and is now in the Paris Herbarium. It is proposed after the Exhibition is over to present this collection to Kew Gardens, or to one of the Universities. Visitors to the South Australian Court will also have an opportunity of examining the magnificent fern-trees of the colony, four of them having been despatched to London for the Exhibition. The trunk of one of these weighed 500 lbs. The Canadian Geological Survey will send a large collection of the minerals of the Dominion; while there will also be collections of Canadian fauna and flora. The animal kingdom of Manitoba and the North-West Territory will be represented with particular care; while the entomological collection will be very comprehensive. Indeed, mineralogy and natural history will form two of the four main departments of the Canadian section. Similarly the mines and the flora of New South Wales will be amply represented. From Victoria comes a large natural history collection, including two young Australian aborigines, and a number of specimens of ferns, which will be arranged in a kind of natural fern-tree gully. The tropical and sub-tropical flora of Queensland will be shown, as will also specimens of the mineral wealth of the colony. From New Zealand comes a large collection of mineralogical and geological specimens, including castings of gigantic fossil reptiles. There will be about 500 specimens of the forest woods of South Africa, and the medical, meteorological, and natural history departments of the Straits Settlements section are receiving special attention from Dr. Rowell. In the West Indian section will be collections o tropical plants from the various islands—pine plants from Antigua, cabbage palms from St. Kitt's, lime-trees from Montserrat, and tree-ferns from Dominica. The process of hatching the ova of turtle will be displayed in this section, which, in addition, will contain a collection of stone implements and relics of the Carib race. There will therefore be no lack in the forthcoming Exhibition of objects deserving of the attention of students in most branches of science.

THE new aquarium which is now being constructed for colonial and Indian fishes, to be shown at the forthcoming Exhibition at South Kensington, is rapidly approaching completion. The building contains twelve tanks in addition to a colossal habitat for turtles, capable of accommodating fifty specimens. In juxtaposition to the latter a hatchery has been erected for incubating the ova of turtle, which will be effected through the medium of heated sand. The hatchery is formed of glass, and contains a grotto arranged in an attractive manner by means of rockwork, over which water will flow into a pool beneath, forming a cascade. The entire aquarium will be heated according to the climatic exigencies of the various fish. Those of India require a temperature of 92°, which is the normal state of their native waters. All the fish will be fresh-water specimens, and on this account great difficulty will attend their transmission to this country. The turtles, however, will be those indigenous to the sea, and comprise chiefly the green turtle (*Chelonia midas*), which will be sent by the West Indian Commissioners in large numbers. The Australian, New Zealand, and Victorian authorities have announced their inability to forward specimens from their respective colonies. This is to be regretted, especially in regard to Australia, from whence some interesting fish could be sent.

THE Japanese Government has decided to erect a meteorological observatory on the Loochoo Islands. The necessary apparatus for this purpose was sent there at the beginning of the year. From the geographical position of the archipelago this observatory should be able to render important services to meteorological science.

WE have received a pamphlet on "The Present Position of the Museum and Art Galleries of Glasgow," published by order of the Town Council, and containing an indictment of that body for its neglect to provide adequately for these two institutions. After sketching their vicissitudes and their present somewhat doleful condition, the writer states what they actually are and what they should be. With regard to this latter it needs only to be said that his observations are, in our judgment, perfectly accurate. He complains that the Kelvingrove Museum has been placed haphazard in an inconvenient and unsuitable position, that no permanent character has been given to the collection, the arrangement being only temporary and provisional, and that its main characteristic at present is its miscellaneous nature. "There is much to excite the attention and to stimulate the curiosity of the ordinary visitor, but the museum displays little which serves to draw the attention of the investigator or the man of special knowledge." He insists on the function of the museum as an educational element in the town rather than a mere show or place of public resort, and on the special duty—not to say necessity—of a city like Glasgow, with vast commercial and industrial interests, to be adequately equipped in this respect. There can be no question as to the justice of the writer's concluding observation: "It is open for the municipality to elect whether a museum shall be established or not; but, having made the choice, it has no right to found such an institution on an insufficient basis, nor to maintain it on a scale which deprives it of its most important and useful function." It may be hoped that the publication by the Council of this sharp attack on itself is a sign of compunction for its shortcomings in the past and a promise of better things in future.

WE have already referred to the anxiety which exists in Japan with regard to the fate of the Imperial Engineering College at Tokio, now that the department under which it was founded and organised has been abolished in recent administrative changes. The institution was a peculiarly English one; it was established and worked by an English principal and a staff of English professors, and the names of many of the latter, past and present, are well known in the scientific world. In a recent article in the *Japan Mail* on the subject of University education in Japan, the editor (himself, we believe, a former professor in the College) writes thus:—"The threatened absorption of the College of Engineering, with its admirable organisation and its complete buildings, into the University (of Tokio), is an event to which enlightened men, and all the friends of Japan, can look only with grave dread. That these buildings, the result of so much thought and care and high ambition, should be divorced from their original purpose, and that the only institution in Japan which might well be called first-class should be ruthlessly uprooted, would be a blow to the higher education in Japan which would make her detractors laugh and her friends hold down their heads in shame." No doubt grave warnings such as these from a writer of experience, whose general sympathy with Japan is recognised, will cause the Japanese authorities to reflect carefully on any step they may take with regard to the College.

PETROLEUM-WELLS are reported to have been discovered at the peninsula of Jemsah, on the west coast of the Red Sea, 170 miles south of Suez, at the foot of the mountain known as Jebel Zeit, or Oil Mountain. M. Deboz, the Belgian engineer, who was sent to search for petroleum in January last, commenced boring at a distance of thirty miles from the sea. After penetrating successively through gypsum, containing veins and nests of sulphur, shale, green and blue clay, limestone, and sandstone, the drill on February 28 fell suddenly 40 centimetres, and petroleum rose to a point 2 metres above the sea-level.

THE Italian Government have lately deposited 500,000 fry in Lake Como, with the view of replenishing the stock of fish. It is the intention of the Government to adopt similar measures in regard to other important lakes. They also have resolved to undertake the propagation of lobsters artificially, thus reviving a branch of fish-culture which previously existed in Italy.

AT the stated meeting of the Royal Irish Academy, held on the 16th inst., Prof. Frankland and Lord Rayleigh were elected as Honorary Members in the Department of Science. The President, Sir S. Ferguson, nominated as Vice-Presidents for the ensuing year, Dr. Ingram, Rev. Dr. Haughton, Sir R. Ball, and Prof. J. P. O'Reilly.

A SOURCE of mineral water was discovered a few days ago in the very centre of St. Petersburg. In the yard of one of the houses situated on the Maika Embankment, close by the Winter Palace, a boring 560 feet deep was made in order to reach the source. In composition this water is said to be like that of Staraya Russa, or Kreuznach, while in taste it is quite similar to genuine seltzer water.

ACCORDING to the communication of the mining engineer, L. P. Dolinski, to the Society of Natural Science of Odessa, a very important discovery of cinnabar mines has been recently made in the mining region of the Don in Russia. The ore contains from 69 to 80 per cent. of pure mercury.

ACCORDING to a medical report just published, the cattle plague continues to ravage various parts of Russia. Within a period of five years, from 1876 to 1880, the loss is estimated at no less than 1,208,500 head of horned cattle; but even these figures, based upon official information, are considered far below the real value.

WE notice in the last issue of the *Izvestia* an interesting paper, by M. Stephanoff, on the religious beliefs of the Chersonese people. Although all Christians, they still adhere to their beliefs in good and evil spirits, and worship them—the good spirits in forests and groves, where coniferous trees are mixed with foliaceous ones; and the evil spirits in purely coniferous forests. Every god is represented by a special tree, and served by a separate priest, who is not hereditary, as with the Siberian Shamanists, but elected by lot. The sacred groves are preserved with great care, and some trees are two and three hundred years old. From time to time, according to orders given by some prophets to whom the gods appear in dreams, thousands of Chersonese, coming from different districts and provinces, meet together in sacred groves to sacrifice hundreds of horses, cows, sheep, and fowls, and to share in a general feast. These considerable expenses are covered by voluntary taxation of all villages taking part in the feast. The paper of M. Stephanoff is accompanied by an interesting illustration of worship.

IN regard to the electro-magnetic rotation of light, Herr Kundt (*Wied. Ann.* 2) notes the fact that all simple substances hitherto examined, be they strongly magnetic or strongly diamagnetic, show positive electro-magnetic rotation. Negative rotation is shown only by chemical compounds, and such as contain atoms of strongly magnetic elements (as iron salts). Positive rotation has been proved in the case of eleven elements, viz. Fe, Co, Ni, Br, Se, S, P, C (diamond), O, N, H.

THE question whether electro-magnetic forces may not have demonstrable action on natural, as well as polarised, light, has been lately taken up by Herr Sohncke (*Wied. Ann.* 2). His guiding idea was this:—It is known that two polarised light-rays from the same source, meeting at a sufficiently acute angle, interfere most if they are polarised parallel, and not at all if polarised at right angles, to each other. Now, natural rays of light from the same source behave, in regard to interference, quite like parallel polarised rays; and it seemed likely that two such rays would lose their power of interference if the direction of vibration (or greater ellipse-axis) of one of them were turned round by electro-magnetic forces 90° relatively to the other, for in this case the two rays would behave like two polarised at right angles to each other. This was effected (in a way he describes). It appears that the same thing was done some years ago by Prof. Abbe, using with natural light the natural rotation of a right and left quartz instead of electro-magnetic; and this before-unpublished method is also developed by Herr Sohncke, who describes a new interference-experiment with natural light.

SINCE Graham's time it has been generally accepted that thin parchment paper is the best material for a dialyser. A variety of substances have been experimented with lately by Herr Zott in Munich (*Wied. Ann.* 2), and he pronounces goldbeaters' skin the best; it has always at least twice the separative effect of parchment paper, and sometimes much more. In a list of relative permeability, goldbeaters' skin being valued as 1, we have next, sow-bladder 0·77, parchment paper 0·5, 2 mm. leather 0·025, and so on to the fifteenth, caoutchouc, 0·0001. For solutions which injure organic membranes, common earthenware cells (like those in Grove's battery) are best; but their effect is sixty to seventy-five times less than that of goldbeater's skin. All phenomena of diffusion are intensified, if the diaphragm is first evacuated in an air-pump; and the more quickly a substance diffuses itself through a diaphragm, the greater is the accelerative effect of evacuation. This evacuation should be renewed after each experiment. It induces endosmose in diaphragms which did not previously show it; and even colloids show a considerable endosmose, even surpassing that of most crystalloids if the time of diffusion is prolonged enough. Solution-mixtures of two substances are more easily and fully separated the further apart their relative velocities of diffusion; and dialytic separation is more rapid the oftener the external water is renewed.

IN a recent communication to the Erlangen Physical-Medical Society Prof. Gerlach describes a successful method he has devised for watching the embryo-growth in birds' eggs through a small glass window made at the sharper end. After detaching the end with a bent pair of scissors, a little albumen is taken out, so that the germinal disk of the yolk turns upwards; then the liquid is put back. Gum-arabic solution is spread on the opening, and wadding put round it; then a small (ladies') watch-glass is fixed on it with gum; collodion and amber-lac being afterwards added. The eggs must lie horizontally in the incubator; development then goes on normally, and may be observed till the fifth day (thus comprising the time most interesting to the embryologist), the egg being taken out and the window-end turned up.

THE French language in Canada, according to M. Demanche n a French review, presents no *patois*, owing to fusion of accents by the well-educated teachers in schools, &c., in the seventeenth century, who came from all parts of France. Further, the Canadian peasant is better educated than the French; and all French-Canadians speak English as well as French (an elevating factor). In France, while foreign words are often adopted without scruple, such as *rail*, *waggon*, *sleeping-car*, *tramway*, *ticket*, *square*, the French-Canadians generally translate, saying, *e.g.*, *lisse*, *char*, *char-dortoir*, *char-urbain*, *billet*, *carré*. The preservation of the French tongue on the banks of the St. Lawrence has been greatly favoured by the prodigious increase of the French-Canadians. Of a total population of 4,324,819 by the last census in 1881, there were 1,298,929 French. The total increase since the beginning of the century gives an annual rate of 21 per cent., while the increase in the United States for the same period is only 15 per cent. annually. In the province of Quebec the French form four-fifths of the population. Celibates are rare in Canada; and families number, on an average, eight to ten children, but sometimes one pair will give birth to twenty-five children. A twenty-sixth child is educated at the cost of the parish.

A NUMBER of workmen were entombed in a subterranean gallery at Chanulade (Dordogne) some time since. The work for their recovery was so unfortunately protracted that all hope of finding them alive was lost for a long period. But it was deemed necessary to continue the excavation in order to procure them a decent burial. This sad part of the programme could not be executed with success. Then it was decided to excavate a small hole and to use it for sending below an electric light and a photographic apparatus to ascertain what was the condition of the wrecked galleries. This operation was delayed by difficulties, but at last executed with complete success. A plate was procured showing the likeness of a young man who had not been crushed but who had evidently died of hunger. It is greatly feared this fate has been shared by others of his unfortunate companions.

ALTHOUGH scientific researches on the habits of the herring on the coast of Norway have been prosecuted almost without interruption since 1861 (at the instance of the late Dr. Axel Boeck), and some valuable results have been obtained therefrom, it is generally felt by those interested in this industry in Norway that there still remains a great deal to be done in this direction, as for instance has been the case in Scotland and Prussia. This is chiefly applicable to the "summer" herring visiting the shores of the provinces of Nordland and Tromsö, where hardly anything is known of the habits of the fish. It is, therefore, proposed, in order to promote this important industry, to prosecute scientific researches on the spawning of the fish, the localities or fiords preferred by it for that purpose, the time of the fish's coming inshore, and the climatic conditions most advantageous to its existence. Considerable fresh light is also expected to be thrown on this subject through the sea-water fish-hatching establishment recently started at Arendal, in the Christiania fiord.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. L. H. G. Morgan; two Azara's Opossums (*Didelphys azaræ* ♂ ♀) from Rosaria, La Plata, presented by Capt. G. W. Freeman; three Striated Finches (*Munia striata*), a Nutmeg Finch (*Munia punctularia*), two Black-headed Finches (*Munia malacca*) from India, presented by Mr. L. B. Lewis; a Thunder Fish (*Misgurnus fossilis*) from Austria, a Ground Loach (*Cobites tænia*) from Russia, presented by Mr. Alban Doran; two Tasmanian Wolves (*Thylacinus cynocephalus* ♂ ♀) from Tasmania, two Red Kangaroos (*Macropus rufus* ♂ ♀), a Great Kangaroo (*Macropus giganteus*) from Australia, a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*), two Hairy-nosed Wombats (*Phascolomys latifrons* ♂ ♀), two Vulpine Phalangers (*Phalangista vulpina*), two King Parrakeets (*Aprosmictus scapulatus*), a Bauer's Broadtail (*Platycercus zonarius*), two Swainson's Lorikeets (*Trichoglossus novæ-hollandiæ*), a Roseate Cockatoo (*Cacatua roseicapilla*) from South Australia, deposited; a Bay Antelope (*Cephalophus dorsalis* ♂) from West Africa, a Green-billed Toucan (*Ramphastos discolorus*) from

Guiana, a Sun Bittern (*Eurypyga helias*) from South America, a Thick-necked Tree Boa (*Epicrates cenchris*) from West Indies, purchased; three Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

An Observation of Neptune Occurring in Lamont's Zones.—Mr. Hind pointed out in the *Astronomische Nachrichten*, No. 712, two cases of observations of Neptune occurring in Lamont's zones, in which the planet was mistaken for a star. The dates of these two observations are respectively October 25, 1845, and September 7, 1846. Prof. Schönfeld, in No. 2716 of the same publication, draws attention to a third instance in which an observation of the planet occurs in these zones. The date of this observation is September 11, 1846. It will be remembered that Neptune was optically discovered by Galle on September 23, 1846. Prof. Schönfeld thinks it advisable to give publicity to his discovery, lest at any time an astronomer should be led to think that this object, which is entered as No. 3818 in the Catalogue in the Munich Supplementband xii. (generally designated Lamont 5), was a "temporary" star.

The Armagh Observatory.—We are glad to learn from a report recently issued by Dr. Dreyer, that an equatorial refractor by Mr. Grubb, having an excellent object-glass of 10 inches aperture, and 10 feet focal length, has been installed in the "Robinson Memorial Dome," erected by the same artist. The instrument has already been brought into use, and a series of micrometric observations of nebulæ has been commenced. We trust therefore that, under Dr. Dreyer's superintendence, the Armagh Observatory is now entering on a career of observational activity which will restore it to the position which it has formerly held as one of the foremost institutions of its kind in the British Isles.

Distribution in Latitude of Solar Phenomena.—M. Tacchini, in a note appearing in the *Comptes rendus*, vol. cii. No. 11, gives a table showing the distribution in heliographic latitude of the various classes of solar phenomena in 1885. The table is remarkable as still further accentuating the difference seen at the present time in the behaviour of sunspots and prominences (Nature, Feb. 25, p. 398). Not only have the prominences shown little or no diminution in dimensions or frequency during the past year, whilst sunspots and faculæ have notably declined, but the prominences are still detected in every latitude from pole to pole, whilst spots, faculæ, and metallic eruptions are confined almost entirely, the spots entirely, to latitudes lower than 40°, and in the great majority of instances to latitudes lower than 20°. The zones showing the greatest frequency for prominences are placed considerably further from the equator. There is also a difference in the proportionate distribution of the different classes of phenomena between the two hemispheres, as the following table will show:—

	Northern hemisphere	Southern hemisphere
Prominences	0·478	0·522
Faculæ	0·367	0·633
Sunspots	0·336	0·664
Metallic eruptions	0·325	0·675

Thus whilst the southern hemisphere has been about twice as prolific in the last three classes as the northern, there has been a much smaller difference between the hemispheres in the matter of prominences. The result of the comparison, on the whole, tends to show that, whilst there is a close connection between spots and metallic eruptions, ordinary prominences are to a great extent independent phenomena; indeed whilst, as already mentioned, sunspots have declined during 1885, prominences have actually been more frequent in the zones in which sunspots have not been seen.

Prominences and Magnetic Disturbances.—The connection between sunspots and magnetic disturbances having been clearly established, it would seem natural to infer from the preceding and other similar indications of the independence of sunspot and prominence activity that but little connection would be traced between individual prominence displays and terrestrial magnetism. A note by M. H. Wild, presented by M. Mascart, appearing in the *Comptes rendus*, vol. cii. No. 9, seems, however, to favour the idea of a somewhat close connection, four remarkable observations of prominence-changes made by M. Trouvelot having been found to synchronise fairly closely with magnetic disturbances. An examination of the magnetic traces at Greenwich has, however, shown that in only one case out of the four was there anything like a sharp disturbance, the movements in the other instances being of a very ordinary character. Further, M. Trouvelot has recently published a series of prominence-observations in the *Bulletin Astronomique* for January, and in no one of these instances was there anything like a magnetic disturbance to correspond to the great and remarkable prominence-change M. Trouvelot was observing in the sun.

Displacement of Lines in Solar Prominences.—The observations of M. Trouvelot above referred to deserve a very careful and detailed examination, as, if confirmed, they will go far to utterly overthrow the views at present held as to the significance of the displacement of lines in the spectra of sunspots and prominences. M. Trouvelot records displacements so extraordinary, that an entire prominence more than 3′ in height was rendered visible when wholly outside the (tangential) slit, which was nearly closed! Other similar phenomena are also recorded, only less astonishing. It is of the utmost importance that, if other spectroscopists have witnessed similar phenomena, they should not delay to publish their experiences, as it seems impossible that displacements of so peculiar a character can be due solely to the motion in the line of sight of the gases under examination. In the meantime it would seem more reasonable to suppose that M. Trouvelot had made some extraordinary error in his observations.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MARCH 28—APRIL 3

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 28

Sun rises, 5h. 46m.; souths, 12h. 5m. 6·6s.; sets, 18h. 24m.; decl. on meridian, 3° 4′ N.: Sidereal Time at Sunset, 6h. 48m.

Moon (one day after Last Quarter) rises, 2h. 19m.; souths, 6h. 48m.; sets, 11h. 19m.; decl. on meridian, 17° 54′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 53	13 0	20 7	12 13 N.
Venus	4 11	9 30	14 49	8 45 S.
Mars	15 16	22 20	5 24*	11 41 N.
Jupiter	17 27	23 38	5 49*	1 23 N.
Saturn	9 33	17 45	1 57*	22 49 N.

* Indicates that the setting is that of the following morning.

March	h.	
30	2	Mercury stationary.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	Mar. 28,	19 14	*m*
R Sculptoris	1 21·7	33 8 S.	,, 29,		*M*
S Ursæ Majoris	12 39·0	61 43 N.	,, 30,		*m*
R Bootis	14 32·2	27 14 N.	,, 28,		*m*
δ Libræ	14 54·9	8 4 S.	,, 28,	5 10	*m*
			Apr. 1,	20 52	*m*
U Coronæ	15 13·6	32 4 N.	Mar. 30,	0 11	*m*
W Herculis	16 31·2	37 34 N.	Apr. 3,		*m*
U Ophiuchi	17 10·8	1 20 N.	Mar. 29,	5 26	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Mar. 31,	0 0	*m*
			Apr. 2,	21 30	*M*
W Sagittarii	17 57·8	29 35 S.	,, 3,	2 20	*m*
U Sagittarii	18 25·2	19 12 S.	Mar. 30,	4 50	*m*
			Apr. 2,	4 50	*M*
β Lyræ	18 45·9	33 14 N.	Mar. 31,	21 30	m_2
R Lyræ	18 51·9	43 48 N.	,, 28,		*m*
η Aquilæ	19 46·7	0 7 N.	Apr. 1,	2 20	*M*
R Sagittæ	20 8·8	16 23 N.	,, 1,		*m*
δ Cephei	22 24·9	57 50 N.	Mar. 28,	4 50	*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor Showers

Meteors from the following radiants may be looked for:—Near δ Ursæ Majoris, R.A. 180°, Decl. 60° N.; near β Bootis, R.A. 223°, Decl. 40° N.; near β Libræ, R.A. 226°, Decl. 8° S. Fireball date, April 2.

THE SUN AND STARS [1]

IV.

Changes of Wave-Length

THE spectroscope not only enables us to determine the chemical constitution of the spots, but it allows us, by the alteration in the refrangibility in the various lines, to determine the rates of motion at which each of the vapours is descending. The hydrogen lines are not thickened as the other lines are in the spots; they are at times thickened on one side only, that is to say, they are what is called contorted. The line suddenly changes its position in the spectrum towards the less refrangible part of the spectrum, which is the red end. Now the amount of change towards the red along the spectrum measures exactly for us the rate of downrush, and we learn generally that the hydrogen is rushing down at the rate of 30 or 40 miles a second. These changes are associated with brightenings of the line, which we shall have to refer to afterwards.

The fact that we get those extraordinary inversions above referred to of the various lines in the spectrum of a substance is simply explained by the assumption that the substance is an exceedingly complicated thing that is broken up into simpler things at the temperature of the sun, and that some of these things exist in some sunspots, while other constituents exist in others. The changes of wave-length come to the support of this argument. If a chemical element is one thing, it cannot be doing two different things at the same time; if its vapour in a spot is homogeneous, one set of lines cannot tell us that it is going up and another that it is going down; but that is exactly what the sun does tell us.

Those results, like the previous ones relating to the inversions, of course are simply and sufficiently explained by the assumption that we are not dealing in any one vapour with one set of molecules only, but that we are really dealing with various constituent molecules, and that some of the molecules may be in one stage of simplicity, some of them may be in another; some may be at rest, while the others may be in very violent motion. These observations of the relative movements of the vapours have been made at different times and in different parts of the spectrum. We get, in all of them, contorted lines, showing us that a particular vapour is moving; while other lines in the spectrum of the same substance indicate that there is no movement whatever in the vapour in that particular spot.

This problem, however, has a very great difficulty connected with it, because it will be readily understood that the slit of the spectroscope has to be kept absolutely on the same part of the sun. It would not do, it would not be fair, for instance, to have the slit of the spectroscope resting on one part of the sun, and then make an observation of a line of any particular substance indicating motion, and then to let it, even by accident, travel on to another part of the spot and find out that the next line of the same substance indicates rest. The answer to that would be—You are dealing with two different parts of the spot. The observations must be made contemporaneously. I may tell you parenthetically that we have a new instrument now which I think will help us very considerably in these inquiries. This is a spectroscope having a diffraction-grating with 17,000 lines to the inch, which gives us, therefore, a very considerable dispersion. What has been done has been to cut the grating in two. If the two parts of the grating are absolutely in the same plane, of course the whole grating will be receiving the light which comes from the sun direct into the spectroscope, and will send a definite part of the spectrum to the eye; both parts of the grating then will be building up a spectrum of the same part of the sun, and will give us the result in the same part of the spectrum. But now that we have split the grating we have the power of altering the inclination of one half of it, while the other half remains rigidly in its first position. Hence we can make any part of the spectrum overlap any other part, and in this way, instead of being limited to observations of parts of the spectrum sufficiently close to each other to be visible in the same field of view, we can compare lines in the red part of the spectrum thrown to the eye by one part of the grating with lines in the blue part of the spectrum thrown by the other. In this way we are able to make comparisons from one end of the spectrum to the other, when there is no doubt whatever that the slit is lying on the same part of the spot; this will be an enormous safeguard against error.

We have taken several photographs of the spectra of sunspots at Kensington; nearly all of them indicate that two lines of calcium in the ultra-violet spectrum—two lines it is difficult to see with the eye—are always bright, while all the rest remain dark. Another important fact is that in addition to the downrush, the velocity of which has been already stated as something like 40 miles a second on the average; there are in the neighbourhood of the spots, in consequence of the disturbances produced, violent movements of the lower parts of the solar atmosphere which we should call *winds*; that is to say, instead of being up and down they are really horizontal along the surface of the sun. Now 140 miles a second is no uncommon velocity for these winds, and we may imagine, therefore, that the heated gases of the photosphere, and the cooler gases of the spots, are very often arranged in layers. When this is so it is easy by the appearance of the widened absorption-lines to determine the existence of a hotter layer above or between cooler ones. We get what is called a double reversal of the lines.

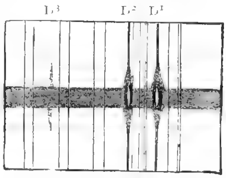


FIG. 8.—Spectrum showing the double reversal of the D lines due to hotter sodium vapour overlying cooler sodium vapour in the sunspot.

Prof. Young, of America, has been fortunate enough to detect one case with, I think, no less than three strata of incandescent sodium vapour inter-layered between three strata of relatively cool sodium vapour. When we wish to consider the phenomena of spots in their entirety therefore, we must not consider the downrush on the photosphere merely, but must also bear in mind the lateral currents which are produced by the disturbances it has set going.

Conclusions

I will now state the conclusions at which we have arrived touching sunspots by means of the work which I have brought before you. You will see they are all of them important with regard to the structure of the lower part of the solar atmosphere.

(1) The spot spectra are very unlike the ordinary Fraunhofer spectrum.

(2) We get as much inversion of lines in the case of one element as we do between the lines of different elements; by which I mean that the lines of nickel, say, are just as much varied in different spots as the lines of iron, nickel, and calcium would be in spots in which the proportions of these substances very greatly varied.

(3) Very few lines indeed are strongly affected at the same time. A great many lines of the same substance are affected of course besides those included in the twelve which have been recorded at South Kensington as most widened every day; but a small number of the lines altogether are affected in this manner.

(4) There is a change depending on what I shall afterwards have to refer to as the sunspot period; that is to say, day after day, month after month, year after year, the lines of any particular substance thickened in the spots are not the same. In fact towards the end of the year 1881 (we began our observations in the year 1879) the iron lines which were strongly affected at first died out altogether.

(5) Many of the lines seen in the spots are lines seen at low temperatures, and none of them are brightened or intensified when we pass from the temperature of the electric arc to that of the electric spark.

(6) In the first 200 spots observed 101 lines were recorded which have never been mapped in any laboratory; that is to say, they do not correspond with lines seen in the emission-spectrum of any substance with which we are familiar.

(7) Many of the lines widened are new solar lines; that is to say, they are not visible among the Fraunhofer lines at all.

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 472.

(8) Many of the lines most frequently seen widened are common to two or more substances when low dispersions are employed.

The Chromosphere

In what has gone before we have been chiefly occupied with a discussion of the various chemical materials which we can trace in those cavities in the photosphere which we call spots. We have now to begin the consideration of the chemical materials which can be traced in that solar envelope which lies immediately over the photosphere, I mean the chromosphere: so that eventually we may endeavour to make a comparison between the chemical materials in the spots and in the chromosphere, which are supposed to lie, and which in fact really do lie, at about the same height in the solar atmosphere, with, however, the enormous difference that we know the spots are caused by the descent of materials coming down from above, and we do not know at present that that is true with regard to the substances in the chomosphere.

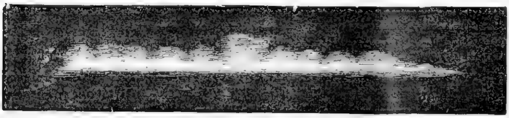


Fig 9—The chromosphere—billowy.

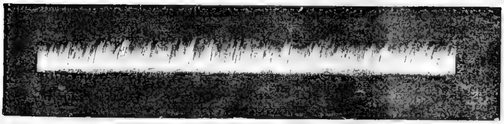


Fig. 10—The chromosphere—spikey

Now, the chromosphere we will take roughly, as it varies in height from year to year, and from latitude to latitude, to be between 5000 and 10,000 miles high. It is not only bright at the bottom—so bright, very often, that in eclipses, when the bottom is seen, observers imagine that the sun has reappeared—but it is exquisitely coloured at the top, the colours very often being scarlet, crimson, green, yellow, and so on. As ordinarily observed, the simple chromosphere varies very considerably.

The first distinction that we have to draw is that in some parts its surface seems to be billowy, in other parts prickly; some have likened the latter condition to grass, some have likened it to flames; but at all events the distinction is that in many cases it is serrated, and in other cases its saw-like appearance gives way to a much softer billowy outline. These spikes, or grass blades, or whatever we may liken them to, really want very much more study than they have received, for the reason that if they are studied they will give us some ideas on a very important subject. What one wants to know now, I think, almost more than anything else, is the direction in which the currents on the surface of the sun flow; a careful study of the direction of these flames may eventually give us some very material aid in that direction.

The chromosphere, taken most generally, is chemically a sea of hydrogen, *plus* something that we do not know. Above the photospheric level, and for some distance above it, the chief substance which we see in the sun is incandescent hydrogen gas. Now, on our earth we have at the present moment no free hydrogen whatever; all the hydrogen we have is locked up in combination with other substances. At the same time it is fair that I should point out that hydrogen is a very considerable constituent of water, which seems to play the same part with regard to the solid crust of the earth as the chromosphere plays with regard to that shell of the sun which we call the photosphere.

Its Spectrum

What one sees when one immerses the slit of the spectroscope in an image of the sun so that only half the slit is covered by the disk is shown in the accompanying diagram of a part of the spectrum. You must imagine that the slit is, as I said before, half on the sun, and half off it. We have the Fraunhofer lines in the red part of the general spectrum of the sun. We see what the spectroscope picks up outside the sun altogether. It picks up one line, and one line only, coincident with a dark line in the ordinary solar spectrum. That we know is a line due to hydrogen. In the chromosphere, this line appears as a bright line because it has not behind it waves of greater energy, and therefore it gives us its own light. You understand in a moment that the height or length of the line depends upon the depth of what I have ventured to call the sea of hydrogen. If this sea is shallow, the line will be short; if the sea is deeper, the line will be longer.

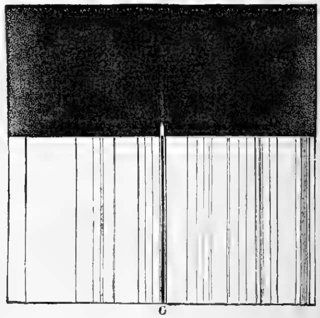


Fig. 11.—One of the hydrogen lines of the chromosphere.

I have said that it is a sea of hydrogen. It is not, however, merely a sea of hydrogen. Of the spectrum of five lines generally thus seen, one of them we do not understand at all. This line is in the orange part of the spectrum, and is called D^3, because it is near to D^1 and D^2; it is a line, I am sorry to say, which has never yet been seen in any terrestrial laboratory.

This, then, is the most simple and the most constant spectrum of the chromosphere.

It has already been pointed out that if the old view that the various substances were assorted in the solar atmosphere according to their atomic weights were correct, then we should have in the chromosphere a spectrum very rich indeed in the lines of the substances with which we are perfectly familiar, and especially in the lines of those substances which are of high atomic weight. The condition which it reveals is just about as opposite as can be imagined.

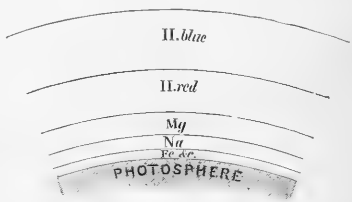


Fig 12.—Early hypothesis of the arrangement of materials in the Sun's atmosphere. H = hydrogen; Mg = Magnesium; Na = sodium; Fe, &c. = iron and the other elements of high atomic weight.

Amongst those who have most closely examined this chromosphere is Prof. Respighi. From his observations we gather that its brilliancy is exceedingly variable in different parts of the sun; that as a rule it is greatest near the spots; that its height, or its depth, if we like that expression better, is greatest at the poles; that it is always shallow near the spots.

Injections

Occasionally the level of this sea over a very large region is gradually, peacefully, and quietly raised, and when that happens we get short lines—shorter than those of hydrogen—of other substances, and the indications afforded by the observations show us that this welling up is due to the intrusion of other vapours. There seems to be a gradual distillation from out the photosphere, or a gradual heating of slowly falling material, and these lines appear delicately over large regions, pushing up the upper level of the sea of hydrogen, so that the spectrum of the portion of the atmosphere near the photosphere gets richer and richer; we get, in fact, layers of different substances.

I give a table showing the lines which have been thus most constantly seen, in addition to the five lines above referred to. The wave-lengths given are from Thalèn and Ångström.

Table showing Lines of Chromosphere

1869	Hydrogen	All lines	
	D^3		
	1474 (5315·9)	Unknown	
	b^1 b^2 b^4	Magnesium	3 out of 7 (T)
	b^3	Nickel	1 ,, 34
	D^1 D^2	Sodium	2 ,, 8
	4933·4, 4899·3	Barium	2 ,, 26
	4923·1, 5017·6	Iron	2 ,, 460 (Å)
	5275, 5233·6, 5179·9, 4921·3, 5014·8 bright	Unknown	
After 1869			
⦶	*f* 4471, 4924·5, B—C, B—*a*	Unknown	
⦶	5019	Titanium	1 out of 201 (T)
	H, K	Calcium	2 ,, 74

Some remarks on this table may be permitted. The first new line is called in spectroscopic language 1474, for the reason that when this work was begun the only maps at the disposal of investigators were those made with great care by Prof. Kirchhoff. He gave a scale of such a nature that this particular line fell at 1474 on that scale. Since then these artificial scales have been discarded in favour of the natural one, which is given us by the actual wave-lengths of light. In this the actual number of that line is 5315·9, which represents the actual wave-length in ten-millionths of a millimetre of that particular quality of light. After this we observe three lines of magnesium—only 3 out of 7. Next, a line of nickel, one only, however, out of 34. Then two lines of sodium. We might naturally expect to get all the 8 lines of sodium, but we do not. Then come two lines of barium out of 26, and so on. For the rest, we see that almost all the other lines have origins which are absolutely unknown, that is to say, we never get them in our terrestrial laboratories, and never, therefore, are able to match the bright lines in this envelope of the sun which we are now discussing with any chemical substance. In the year 1871 we got other lines added to those first observed, because, as we shall see by and by, the sun was then more active, and this activity resulted in the addition of new lines, all of them, however, as you see, absolutely unknown to us, except one which represents a line which we observe in the spectrum of titanium; but in that case we get one line out of 201 in exactly the same way as we get two only of iron out of 460.

The latest constant addition to the lines of this envelope are H and K, two lines so named among the Fraunhofer lines, which we have already seen brightened in spots. Here, again, as in the case of iron and titanium, we only get two lines out of a large number.

Now, over certain reaches of the sun these injections, as we may call them, have been seen to last for a fortnight, quite independent of any spot in the locality, and while the rest of the periphery of the sun has been more or less tranquil.

Here is a drawing showing two gentle wellings up of the chromosphere to which I have referred. The distance from the horizontal line shows the depth of the strata indicated by the lengths of the various lines. The stratum which reaches highest up has a spectrum containing a certain line of magnesium. The next, which is shallower, consists of a substance about which we know nothing, except that its line is called "1474." Then, again, we get other shallower strata giving us still shorter lines. These, again, are of unknown origin. The lower we go the deeper does the mystery become.

The next point it is important to notice is that none of the lines which we have in the table as representing the spectrum of the chromosphere, and those special lines to which reference is now being made as representing the usual commencement of an injection into the chromosphere below, are among those which are widened in the spots. That is an important point to make, and we shall have to refer to it again by and by.

The announcement that iron existed in the sun, an announcement made by Kirchhoff a good many years ago now, was

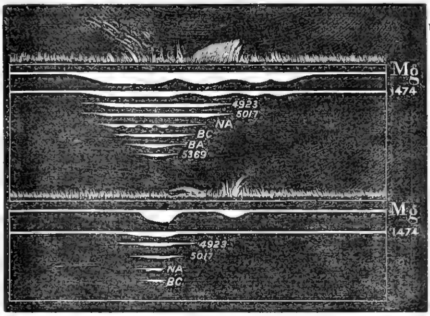


FIG. 13.—Wellings up of vapours.

made because he found, or said he found, that all the lines which we see in our laboratories agreed absolutely, both in position and relative strength, with the lines which can be seen in the spectrum of the sun. If that reasoning is good for the general spectrum of the sun, and if we assume it to be equally good for the spectrum of this special part of the sun—viz. the chromosphere—you will see that if we accept Kirchhoff's line of argument we have no right whatever to say that any of the chemical substances that we are familiar with here exist in this part of the sun, which, as I have told you, is the very hottest part to which we can direct any inquiries.

So much, then, for a general statement with regard to the chemical nature of the chromosphere.

The Chromosphere Disturbed

These injections are at times the first beginnings of an apparent disturbance of the temperature equilibrium, or at all events of the chemical equilibrium of the chromosphere, for, soon after they make their appearance, we frequently get another indication that there is a disturbance going on by the formation of what is called a prominence—a *quiet* prominence; and when we are familiar with those forms of prominences the distinction between a quiet prominence and one of the other kind is a very decided one.

As a rule they need not be very high. By very high I mean 40,000 miles. And also these quiet prominences may last for a very long time. Many of them resemble trees. I was fortunate enough to be one of the early observers of these exquisite forms which one never gets tired of looking at, and the first time I saw one I wrote down in my note-book that the chromosphere and prominences in that place reminded me of an English hedge-row with luxuriant elms. The lower part of the chromosphere, of course, represented the hedge, and the prominences the elms. The simile of a hedge with trees in it was not at all a bad one, but some years afterwards I found a very much better one, and one perhaps nearer the truth of Nature. It was my duty in the year 1878 to go to America to look at an eclipse. I crossed the Atlantic in the high summer, and we naturally had to pass through a considerable amount of fog. We were three days in a dense fog, and one of the delightful things about that fog was this, that one day we were steaming through an opening, and we saw the edge of the fog, which was apparently upright and solid, about a mile off, and we coasted along it. I found that that fog was fed by what I at once called fog-spouts. You know what water-spouts are, and you have all seen drawings of them, and the drawings of water-spouts that I have seen represent the reality very well. If you imagine a bank of fog about 50 or 60 feet high filled with little fog-spouts, you get exactly what I then saw, and you get exactly what one often sees in these quiet prominences on the sun, and I really believe that what I and others have likened to the trunks of trees may be really somewhat akin to these fog-spouts, with the enormous difference, however, that we are dealing with water and aqueous vapour in one case, and with the photosphere of the sun and incandescent hydrogen gas in the other.

These quiet prominences, when we come to examine them with the spectroscope, seem to be built up entirely of hydrogen. When I say quiet you must understand that the word is a relative one. I have seen a quiet prominence as big as a dozen earths born and die in an hour. That is not at all an uncommon thing. And there are several facts which indicate that when such a prominence disappears, it does not mean that the stuff

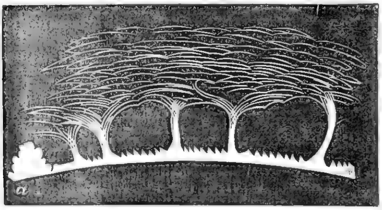


FIG. 14.—Tree-like prominences.

disappears; it means that it changes its state, that is to say, it chiefly changes its temperature. We can understand that these prominences, if they are excessively hot, will be very much more brilliant than if they are cool. If, therefore, they cool more or less suddenly, we may lose sight of them, but it may be that the hydrogen is there just the same, although it is no longer in a condition to radiate so much heat, and therefore light, to us. There is also evidence that these prominences are really, the quietest of them, due to up-rushes of gas from below.

When we watch the growth of a prominence it expands from below, close to the photosphere. First the prominence is of small height, then it gets higher and generally broader, and after a certain time we may see a kind of cloud formed at the top of it, but we never see the prominence coming down, as we have imagined the cooler materials of the sun must come down, to form a spot.

It happens very rarely indeed that any very large horizontal motion is indicated in such prominences as these. Drawings of prominences indicate very clearly the extraordinarily curious forms which these masses, which consist chiefly or entirely of hydrogen gas in the sun's atmosphere, put on.

J. NORMAN LOCKYER

(*To be continued.*)

SOCIETIES AND ACADEMIES

LONDON

Geological Society, February 19.—Annual General Meeting.—Prof. T. G. Bonney, F.R.S., President, in the chair.—The Secretary read the Reports of the Council and of the Library and Museum Committee for the year 1885. In the former the Council stated that they had the pleasure of congratulating the Society upon an improvement in the state of its affairs, both from a financial point of view and on account of an increase in the number of Fellows. The number of Fellows elected during the year was 54, and the total accession amounted to 51; while the losses by death, resignation, &c., amounted to 46, making an increase of 5 in the number of Fellows. The number of contributing Fellows was increased by 15. The balance-sheet showed an excess of income over expenditure during the year of 347*l.* 18*s.* 2*d.* The Council's Report further announced the awards of the various medals and of the proceeds of the donation funds in the gift of the Society. In handing the Wollaston Gold Medal to Mr. Warington W. Smyth, F.R.S., for transmission to Prof. A. L. O. Des Cloizeaux, the President addressed him as follows:—Mr. Warington Smyth,—In the absence, which we much regret, of Prof. Des Cloizeaux, I must request you to transmit to him this medal. Geology is the child of two parents—mineralogy and biology. If we look to the latter to bid the dry bones and buried relics of organisms once more live, we appeal to the former to disclose the nature and constitution of the earth's framework whereon they flourished. It is therefore only just that our Society should seek opportunities of acknowledging the aid which we receive from mineralogists; and it would be difficult to find one on whom this Wollaston Medal could be more fitly conferred than on Prof. Des Cloizeaux. To enumerate the papers which he has written would be a formidable task; they numbered 141 so long as fourteen years ago; what, then, must be the present total? I may, however, point in passing to his admirable "Manuel de Minéralogie," and allude, as more directly bearing on the work of this Society, to his papers on the classification of hyperites and euphotides, on the geysers of Iceland, on the action of heat upon the position of the optic axes in a mineral, and the numerous memoirs on the distinction of minerals by their optical properties, especially those relating to microcline, and to other species of feldspar, of the importance of which students of microscopic petrology are daily more sensible. I esteem it a great honour to be the means of carrying into effect the award of the Council by placing in your hands, to be transmitted to Prof. Des Cloizeaux, the Wollaston Medal, founded "to promote researches concerning the mineral structure of the earth."—The President then presented the balance of the proceeds of the Wollaston Donation Fund to Mr. J. Starkie Gardner, F.G.S., and addressed him as follows:—Mr. Starkie Gardner,—The small number of students and the paucity of memoirs seems to indicate that fossil botany is one of those subjects of which the difficulties repel rather than fascinate the neophyte. If these are in some respects less formidable in the plant-remains of the earlier Tertiary period, if, in studying them, recent research throws some light on fossil botany, yet the practical difficulties of obtaining, developing, and preserving specimens are so great that no little ardour and patience are demanded from one who devotes himself to the subject. For years this has been your special work: after thoroughly exploring the flora of the Eocene Tertiaries on the coast of Hampshire and in the Isle of Wight, you are now, and have for some time been, engaged in communicating to us the fruits of your labours through the medium of the Palæontographical Society, thereby earning the thanks of students. Your researches also of late years have been extended to Antrim, Mull, and even Iceland, and their results cannot fail to be of the highest interest in regard to the age of these floras, and their relation to those which occur in the Hampshire district. In recognition of past, and in aid of future, work the Council has awarded to you the balance of the Wollaston Fund, which I have much pleasure in handing to you.—The President next presented the Murchison Medal to Mr. William Whitaker, B.A., F.G.S., and addressed him as follows:—Mr. William Whitaker,—To many members of the Geological Survey of Great Britain since the date of its constitution we are indebted for work freely done—beyond the sphere of their more strictly professional duties. Its chiefs, from the days of Sir H. de la Beche to the present distinguished Director-General, Dr. A. Geikie, have been among the most valued contributors to our *Journal*, and have enriched geological literature by their longer writings; while among its other members, few have done more than yourself in following the example of its leaders. On the present occasion I will only allude to the various memoirs of the Geological Survey, especially that on the London Basin, in which you have taken so large and important a share, and will dwell rather on your contributions to our own *Journal* and to other publications. Your papers on the western end of the London Basin and on the Lower London Tertiaries of Kent deserve to be ranked with the classic memoirs of Prestwich as elucidating the geology of what I may call the Home District; and your last contribution to its deep-seated geology is still too fresh in our memories to need more than a mention. We do not forget your varied and valuable contributions to the *Geological Magazine*, especially those on the Red Chalk of Norfolk, on the water-supply from the Chalk, on the formation of the Chesil Bank (written jointly with Mr. Bristow), a paper, as it seems to me, of remarkable suggestiveness; and last, but by no means least, on sub-aërial denudation, in which, as remarked by the late Mr. C. Darwin, you had "the good fortune to bring conviction to the minds" of your fellow-workers by means of "a single memoir." We are also greatly indebted to you for your labours in reference to the history of the literature of geology, a task involving not a little labour, which, though of the greatest value to students, is to all unremunerative, and would be, to many, exceptionally toilsome. Of this, your care for several years of the *Geological Record*, and the lists of books and memoirs relating to the geology of various counties in England, are conspicuous instances. There is a peculiar appropriateness in the award to you of this medal, founded by Sir Roderick Murchison, one of the illustrious chiefs of your Survey, and I have the greatest pleasure, on behalf of the Council of the Geological Society, in placing it in your hands, together with the customary grant from the Fund.—In presenting the balance of the proceeds of the Murchison Geological Fund to Mr. Clement Reid, F.G.S., the President said:—Mr. Clement Reid,—The later Pliocene and the Pleistocene deposits of East Anglia offer to geologists a series of problems as difficult as they are attractive. We are indebted to you for much valuable information on the exact distribution and the fossil contents of these varied deposits, which owing to peculiar local circumstances often present exceptional difficulties, and demand exceptionally patient study on the part of the investigators. Your memoir on the Forest Bed of Norfolk is a contribution of especial value to students as affording them fuller and more precise information than could previously be obtained, while the pages of our *Journal* and of the *Geological Magazine* testify to the zeal and thoroughness with which you have applied yourself to these and kindred questions. In conferring upon you this award from the Murchison Fund, which I have great pleasure in placing in your hands, the Council of the Geological Society hopes that it may aid you in prosecuting your studies in this department of geology and extending them to localities which could not be visited by you in the discharge of your professional duties as a Member of the Geological Survey of Great Britain.—The President next presented the Lyell Medal to Mr. William Pengelly, F.R.S., F.G.S., and addressed him as follows:—Mr. Pengelly,—The Council of the Geological Society has awarded you the Lyell Medal and a sum of twenty guineas from the Fund in recognition of your life-long labours in the cause of geology, and more especially, of your investigations in those caverns of the southwest of England by means of which our knowledge of the condition of Britain during the latest epoch of geological history has been so largely augmented. To exhume the contents of a cavern, not only the lair of wild beasts, but also an abode of men in those ages when, to quote the words of the old Greek tragedian,

"Like tiny ants they dwelt in sunless caves,"[1]

requires the exercise of unwearied patience and, in addition, of extensive knowledge and critical acumen. By the labours of the Committee, of which you were the hands and the eyes, and at least a fair proportion of the compound brain, Mr. MacEnery's long-neglected discovery in Kent's Hole was placed beyond all dispute, and the contents of that cavern, its succession of deposits, its relics of extinct animals, and its tools of stone and bone, denoting more than one stage of civilisation, have been made known to the world. In like way the virgin ground of the Brixham cave was investigated, and its valuable contents have been rendered accessible to students. All this you have done, not as the fruit of secured leisure, but in the intervals of a busy life, of which, in the full sense of the words, time was money; and you began this work at a period when, owing to mistaken prejudices, you incurred no small risk of obloquy and personal loss. Your work at Bovey Tracey and your papers on the later geology of Devonshire and Cornwall are too well known to need more than a passing allusion; the Torquay Museum and the *Transactions* of the local societies will be a lasting monument of your zeal in stimulating scientific researches in the neighbourhood of your home. There is a peculiar fitness in the award to you of this Medal, a memorial of the fearless and illustrious author of the "Principles of Geology" and of the "Antiquity of Man." I esteem myself exceptionally fortunate in being commissioned to place it in your hands, and being thus enabled to testify my regard for so valued and genial a friend. —In handing the balance of the proceeds of the Lyell Donation Fund to Dr. Henry Woodward, F.R.S., F.G.S., for transmission to Mr. D. Mackintosh, F.G.S., the President addressed him as follows:—Dr. Woodward,—I have much pleasure in placing in your hands, as representing Mr. Mackintosh, the balance of the Lyell Donation Fund awarded to him by the Council of the Geological Society. In him we have a second instance of the way in which, through an untiring zeal for science, the rare intervals of a hard-worked life may bear fruit so largely augmenting the common stock of geological knowledge. There are few problems more interesting than that of the physical condition of our native land during the period commonly designated the Glacial epoch; but for its solution an exact knowledge of the distribution of erratics and an identification of their points of departure is absolutely necessary. Those who, like myself, have attempted to adjust the rival claims of glacier and floe, of the ice-chariot *versus* the ice-ship, as vehicles of boulder-transport, can hardly speak too highly of the value of the papers on British erratics which he has contributed to our *Journal* and to other publications. I trust that this award may not only be gratifying to him as a mark of our appreciation, but also help him in continuing his labours in a field where, notwithstanding them, much still remains to be done.—The President then handed the award from the Barlow-Jameson Fund to Dr. W. T. Blanford, F.R.S., for transmission to Dr. H. J. Johnston-Lavis, F.G.S., and addressed him as follows:—Dr. Blanford,—I will ask you to transmit this award to Mr. Johnston-Lavis. In this country happily the volcanic fires have long ceased to glow, and the earthquake seldom causes more than a transient tremor. It is otherwise on the shores of the Bay of Naples, where again and again during the last eighteen centuries Vesuvius has rained down ruin; and of late years the earthquakes of Ischia have wrought destruction on the works, and desolation in the homes, of men. It is true that these phenomena of the darker side of nature have not been unobserved by the many illustrious men of science to whom Italy has given birth; but "the curse of Babel" has debarred some of us from access to their works. This alone gives an exceptional value to the elaborate studies which Mr. Johnston-Lavis has undertaken of the various eruptive products of Vesuvius and of the Ischian earthquakes. There is yet another advantage, that natural phenomena should be studied by men of different nations, diverse training, and varied habits of mind. In recognition of his past labours and in furtherance of future work in the vicinity of Naples, the Council has awarded to him a grant from the Barlow-Jameson Fund, which I have much pleasure in placing in your hands.—The President then read his Anniversary Address, in which, after giving obituary notices of some of the Members lost by the Society during the year 1885, he referred to the principal contributions to geological knowledge which have been made during the past year, both in the publications of the Society and elsewhere in Britain. The remainder of the address was devoted to a discussion of the principles of nomenclature which should be followed in regard to the metamorphic rocks. After describing the nature and relations of the various metamorphic rocks in certain parts of the Alps, Canada, Scotland, &c., the effects of the intrusion of igneous rocks, and the results of pressure in producing changes, both mechanical and chemical, upon rocks originally crystalline, he pointed out that these last could generally be distinguished from anterior foliation, otherwise produced; that many rocks in the metamorphic series appear to have originated in stratified deposits, but that the evidence at present in our possession pointed to the very great antiquity of all these, and to the probability of their having been produced under conditions which have not recurred since the beginning of the Palæozoic period.—The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President: Prof. J. W. Judd, F.R.S.; Vice-Presidents: H. Bauerman, John Evans, F.R.S., A. Geikie, F.R.S., and J. A. Phillips, F.R.S.; Secretaries: W. T. Blanford, F.R.S., and W. H. Hudleston, F.R.S.; Foreign Secretary: Warington W. Smyth, F.R.S.; Treasurer: Prof. T. Wiltshire, F.L.S.; Council: H. Bauerman, W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., Thomas Davies, Prof. P. Martin Duncan, F.R.S., John Evans, F.R.S., A. Geikie, F.R.S., Henry Hicks, F.R.S., G. J. Hinde, Ph.D., J. Hopkinson, W. H. Hudleston, F.R.S., Prof. T. M'Kenny Hughes, M.A., Prof. T. Rupert Jones, F.R.S., Prof. J. W. Judd, F.R.S., R. Lydekker, B.A., J. E. Marr, M.A., J. A. Phillips, F.R.S., Prof. H. G. Seeley, F.R.S., Warington W. Smyth, F.R.S., J. J. H. Teall, M.A., W. Topley, Prof. T. Wiltshire, F.L.S., Henry Woodward, F.R.S.

Paris

Academy of Sciences, March 15.—M. Jurien de la Gravière, President, in the chair.—On the authenticity and exact value of the Peruvian unit of measure preserved in the Paris Observatory, by M. C. Wolf. The French legal metre being defined as a determined fraction of this standard taken at the temperature of 13° Réaumur, the importance of ascertaining

[1] Æschylus, Prom. Vinct., 491.

its exact value and state of preservation is obvious. As the same standard was used for the measurement of an arc of the meridian in Peru, it forms the connecting link between the older and more recent geodetic operations. It thus becomes an object of the highest interest, not only for France, but for the whole scientific world, and the author here replies in detail to the doubts and objections that have been raised by Peters and others in Germany against its authenticity and state of preservation. At his request the whole question will be submitted to a Commission appointed for the purpose by the Academy, consisting of MM. Faye, Mouchez, Janssen, F. Perrier, and Wolf.—Memoir on the order in which the first vessels in the leaves of the Cruciferæ make their appearance: mixed formation, and morphogeny, by M. A. Trécul. The leaves of all the plants here treated belong to one of the two types of mixed formation described by the author in 1853, that in which the lobes or teeth of the lower part of the leaf are formed from above downwards, while those of the upper part are developed in the contrary direction from below upwards.—Theoretical considerations on the principles affecting the roll of vessels at sea, in connection with M. de Burry's recent communication (*Comptes rendus* of January 4, 1886), by M. A. Ledieu. It is shown that M. de Burry's conclusions cannot be accepted because based on de Benazé and Risbec's formulas, which are applicable only to ships in smooth water, account being taken of the resistance of the keel.—Remarks in connection with the *Bulletin* of the Society for the Encouragement of National Industry, presented to the Academy by M. Haton de la Goupillière.—Note on the hurricane that swept the Gulf of Aden in June 1885, by Vice-Admiral Cloué. The cyclone, in which five large vessels foundered, including the German corvette *Augusta*, and the French aviso *Le Renard*, both with all hands, and in which probably over 800 lives were lost, was especially remarkable for its sudden appearance. As it penetrated up the Gulf, it contracted from a diameter of 150 miles 250 miles east of Socotra to 50 miles at Obock, increasing in velocity from 8 to 15 miles an hour. The diameter appears to have continued to contract towards the interior of the continent, where it overtook a caravan proceeding from Sangallo in the direction of Shoa.—Remarks on the first botanical collections that have reached the Paris Natural History Museum from Tonquin (continued), by M. Ed. Bureau. Although collected exclusively in the delta of the Red River and surrounding hills, this flora includes no less than 407 species, distributed over 95 families. It comprises probably not a fourth of the whole flora of Tonquin, which thus appears to be one of the richest in the world.—Note on the ephemeris of Fabry's comet, by M. Lebeuf.—Complementary note on the barometric depressions observed by M. Perrin on board the *Galissonnière* in the Red Sea, by M. Mouchez.—Simplifications which may be effected in the numerical calculation of perturbations of planets, by M. O. Callandreau.—On the latitudinal distribution of the solar phenomena observed during the year 1885, by M. P. Tacchini. The general conclusions arrived at are—(1) In 1885 the solar phenomena were more frequent in the southern hemisphere; (2) while the protuberances appear in each zone, the spots, faculæ, and eruptions are confined almost entirely to the regions between the equator and $\pm 40°$, one eruption and one facula alone being recorded in higher latitudes; (3) the maximum of eruptions, spots, and faculæ occurs in the same zone of the southern hemisphere; (4) eruptions were less frequent in 1885 than in 1884, which was also true of the solar spots, showing the connection between these two phenomena; (5) the protuberances, on the contrary, were more frequent in the zones where no spots occurred.—On the theory of diversities in mathematical analysis, by M. Lipschitz.—Note on the construction of the tangents to plane curves, and determination of the point at which a movable straight line touches its envelope, by M. René Godefroy.—On the determination of the coefficient of self-induction; application of the Deprez d'Arsonval aperiodic galvanometer, by M. Ledeboer.—Application of the colour-diagram to experiments made on a colour-blind person, by M. Feret.—Description of a new apparatus for the quantitative analysis of oxygenated waters (one illustration), by M. Maurice de Thierry.—On selenides of sodium and of potassium, by M. Charles Fabre.—On the formation and dissociation of manganates of baryta and strontian, by M. G. Rousseau. The author had already shown that, under temperatures increasing from dark red upwards, the manganates of baryta and strontian become dissociated at a maximum of 1000° to 1100°, the limit being marked by the formation of a diamanganate, which at a still higher temperature returns to the state of a monomanganite. He now finds that, by raising the temperature to a white heat, this manganite disappears in its turn, passing to a maximum of oxidation and becoming integrally transformed to manganate.—On the various degrees of solubility possessed by certain chlorides in the presence of hydrochloric acid, by M. R. Engel.—Description of various processes for the separation and quantitative analysis of copper, cadmium, zinc, nickel, &c., by M. Ad. Carnot.—On the existence of the elements of sugar of milk in plants, by M. A. Müntz. Although hitherto rarely detected, it is shown that these elements are found in great abundance in plants, and that the vegetable products yielding galactose are very numerous.—On the decomposition of the sodico-ammoniacal and sodico-potassic racemates, by M. G. Wyrouboff.—On the seat of the organ of taste in the coleopterous insects, by M. J. Gazagnaire.—On the labrum of the Hymenopteræ, by M. Joannes Chatin.—On the processes of fructification in the fossil calamodendrons, by M. B. Renault.—Complementary observations on the origin of the diamantiferous sands of South Africa, by M. Stanislas Meunier.—On the eruptive rocks and stratified formations of the Serrania de Ronda system, south of Spain, by MM. Michel Lévy and J. Bergeron.—On the optical properties of grünerite, withamite, and some other minerals destitute of determinable crystalline forms, by M. A. Lacroix.—On the spectrum of the Yα earth, by M. W. Crookes.—On the mosandrine earth of Lawrence Smith, by M. Lecoq de Boisbaudran.

BOOKS RECEIVED

"Turkestan," by J. Mochketon (St. Petersburg).—"The Statesman's Year-Book, 1886," edited by J. S. Keltie (Macmillan and Co.).—"Scientific Memoirs by Medical Officers of the Army of India," part i., 1884 (Calcutta).—"Minutes of the Sixth Annual Convention of the Provincial Educational Association of Nova Scotia, July 15 and 16, 1885" (Macnab, Halifax).—"Existing Glaciers in the United States," by J. C. Russell (Washington).—"L'Evolution et la Vie," by D. Cochin (G. Masson, Paris).—"Hourly Meteorological Readings, 1883," part iii., July to September).—"Christy's Guide to Poultry Rearing," new edition, by T. Christy.—"Annales del Museo Nacional de Buenos Aires, Entrega Décimacuarta," Segunda del toma iii., by German Burmeister (Buenos Aires).

CONTENTS

THURSDAY, APRIL 1, 1886

A FISHERY BOARD FOR ENGLAND

IN the House of Commons, on March 6, Sir Edward Birkbeck pressed upon the consideration of the Government the advisability of taking immediate steps to give effect to the recommendations of the Trawling Commission. Few men could have handled the question with so much knowledge and force. Sir E. Birkbeck pointed out that there is urgent need for a central department for the administration of business connected with sea-fisheries, and in supporting his appeal exhibited a detailed knowledge of the clumsy state of the existing arrangements and a wide acquaintance with the statistics and conditions of fishing industries. He pointed out that Scotland and Ireland possessed each a Fishery Board with considerable powers, complete organisation, and liberally supplied with public money. He recommended that a Fishery Board for England should be established which should unite the powers and functions now distributed among the Government Offices. The duties of the Board suggested were that it should collect detailed statistics as to the amount of fish taken, its value, and the number of vessels and hands employed ; that it should be responsible for the registration of fishing-vessels ; and should be able to recommend legislation when necessary or advisable. The author of the motion further recommended that the Board should divide the English coast into Fishery Districts, each with its Fishery Officer, and that the supreme control of the salmon and other inland fisheries should also be vested in the new authority. Mr. Mundella replied that the Government accepted the principle of the motion, and were about to carry it out by constituting a Committee of the Board of Trade which should be responsible for matters connected with the fisheries, but reminded the House that a Bill would have to be passed to transfer the powers at present vested in the Home Office to the new sub-department.

The present Government are thus pledged to the formation of what is practically an English Fishery Board. If a Fishery Board is useful and valuable it is a surprising fact that Ireland and Scotland have long enjoyed an institution which is wanting in England. It would seem that so much fear exists lest the smaller constituents of the United Kingdom should be neglected or unjustly treated that England is in danger of suffering from complete maternal self-sacrifice. But now that the deficiency is to be remedied it is necessary to consider carefully how the new institution can best be constructed. It is easier to provide good arrangements in the course of construction than to remedy mistakes afterwards. Sir Edward Birkbeck pointed out what functions he thought the new department should undertake. Mr. Mundella refrained from entering into details, only mentioning the subject of floating grog-shops as one requiring immediate attention. Sir E. Birkbeck's recommendations are apparently founded on his knowledge of the constitution of the Irish and Scottish Boards, but he did not enter upon the question of scientific work. He thought that the Board should include a practical element. But the question of what "practical" means depends largely on the particular practice to be carried on. The ordinary interpretation of the word would mean that some member of the Board or Committee should be a man who had been personally engaged in the fishing industry. We have miners in the House of Commons, and doubtless an intelligent fisherman would be useful on a Fishery Board. But the Trawling Commission recommended that money should be granted to the Scottish Board for the purpose of conducting scientific investigations, and that a central authority for the United Kingdom should, when created, also carry on scientific work and collect fishery statistics. For scientific work the practical element means men of science to do the work. The principle is now recognised by several examples. A Professor of Zoology was appointed to the Trawling Commission, and another by the influence of the Scottish Meteorological Society, to the Scottish Fishery Board. A training in science does not always include a training in business details. But in a Fishery Board, and especially in its scientific work, the purely administrative and business work are of subordinate importance compared with the necessity that the inquiries and actions of the department should be carried on by men who have special knowledge of animals, and particularly of marine life. This principle is recognised in other countries. The Fishery Commissioner of the United States is a distinguished man of science, and his colleagues and many of his subordinates are trained scientific men. The Commission for the Investigation of the German Seas is composed of distinguished men who are students and teachers of biology or physics. In Norway and Holland the same thing occurs. It is to be hoped that we in England shall not commit the error of entrusting the affairs of a Fishery Department entirely to men whose only training has been legal or commercial. The mere collection of fishery statistics can only be efficiently carried out, or at least controlled and directed, by men of some scientific training. Fishermen themselves, as was abundantly shown during the inquiries of the Trawling Commission, are too uneducated to estimate truly the meaning of the things they see. For this reason their views and statements must be subject to the criticism of exact science. As the Trawling Commission concluded, it is impossible to discover the causes or measure the fluctuations of the fisheries in the absence of a proper system of fishery statistics and scientific observations. The new laboratory now being founded by the Marine Biological Association will form an important central station for the accurate investigation of fishery questions, and, with the co-operation of smaller and sometimes temporary laboratories at other parts of the coast, some real knowledge of the conditions of our fisheries may be obtained.

As an instance of the care and knowledge which must be devoted to inquiries concerning fishery matters, we may point out that in the Second Annual Report of the Scottish Fishery Board, a fish was described as of a species new to the northern region of the German Ocean, which really belonged to a species long known to be common in the district where it was taken. We believe that only two herring-spawning beds off the coast of Britain are at all accurately known. It is manifestly advisable that our knowledge of the herring, perhaps the most important of our food-fishes, should include an exact knowledge of all the spawning beds round the coast. The assertions of fishermen would be a guide to the acquisition of this knowledge, but it would require scientific men to ascertain the position and extent of the spawning areas, and properly mark them out on a chart. A large number of matters connected with the fisheries have not yet begun to receive attention even in Scotland. The spawn of the sprat is still entirely unknown. The smelt fisheries have never yet, we believe, been examined, and complaints are made in some places that the number of smelt has been seriously diminished by the capture of the young in tidal bag-nets. Statistics of the smaller fisheries ought to be obtained, as well as of the larger, for in many cases these smaller fisheries could be largely developed by intelligent methods. As we have already said, the collection of these statistics requires zoological knowledge, for the same species often bears several local names, which would be put down by an untrained officer as belonging to as many different kinds of fish. What is wanted is a proper division of labour. It does not require a biologist to draw up statistics concerning boats and crews, or carry on purely administrative work. But a large proportion of the work which a Fishery Board ought to carry out is really scientific work, and can only be done by men of science.

Sir Edward Birkbeck very properly included among the functions of the proposed authority that of advising legislation when necessary. The public have learnt by several examples how dangerous it is to legislate in fishery matters, apart from the mere introduction of police regulations, without the basis of results established by experiment. In many cases the laws passed have been themselves experiments, but as the conditions under which they were carried out were complicated, and not properly studied, little accurate knowledge has been gained from them. The Scottish Fishery Board is about to try an extensive experiment with regard to beam trawling, prohibiting that method of fishing in certain defined areas. The experiment is worth trying, even at the cost of temporary inconvenience to the fishery industry. But in order to render such an experiment fruitful, it would be necessary to make a detailed and exact investigation of the areas selected. It is doubtful whether the organisation of the scientific department of the Scottish Board is yet in a position to make this investigation in a sufficiently complete manner. But there can be no doubt that such experiments should be repeatedly made on a sufficiently large scale ; and on their results legislation may be based with some safety. Without them it is better not to legislate at all. No one is at present in a position to say how far artificial propagation can be applied to sea fishes with results economically successful. In America even the extensive resources of the Fish Commission have not yet settled this question. In view of the annually increasing efficiency in the means of capture of marine fish, it would be certainly wise to lose no time in at least ascertaining by suitable experiments, if it be at all possible to add by human intervention to the supplies of sea fishes provided by unaided nature. The harvest of the sea has been gathered by man for ages; the time may yet come when it will also be sown by human foresight.

Moreover, beyond and above the necessity for practical scientific work, there is another advantage which inevitably follows from the association of scientific investigation with the work of a Fishery Board. The results include additions to abstract scientific knowledge, and facilitate in many ways purely scientific researches. The extent to which biology especially has been enriched by work primarily intended to develop the fisheries is well known. It is not to the credit of the United Kingdom that this remark applies chiefly to foreign countries. The valuable aid which the Fish Commission renders to biological science in America can scarcely be too highly estimated. The attention which has been paid to the questions concerning the breeding of fishes has advanced our knowledge of teleostean embryology much more rapidly than would have been possible from purely academic work. The scientific public, then, should insist that exact science be represented in the English Fishery Department, by whatever title it may be called. At least one leading official of the department should be a biologist of recognised standing, who could properly organise the scientific inquiries which must necessarily be undertaken. It would be well if at least one other member were a meteorologist or a physicist. It is inevitable that the new department, if it is to be of any use at all, must apply to men of science for counsel and assistance, and this assistance can most efficiently be rendered by men of science who are members of the administrative body. In this way the organising and directing power of one or possibly two scientific authorities should be secured for the department, but, in addition to this, a staff of subordinates trained as scientific naturalists is absolutely necessary to carry on the actual work of inquiry and observation. These officers must be really competent men, or their services will be worse than useless. They should also be *permanently* employed, and not asked casually to undertake an inquiry. No doubt the department should have the power and the necessary funds to retain the services from time to time of the most highly-skilled men of science to carry on special investigations in connection with questions which arise. But every man of science knows that constant and permanent occupation in a special branch of inquiry, without uncertainty as to pecuniary conditions or undue anxiety to obtain a striking result in a short space of time, is the most favourable condition for the production of really trustworthy and progressive scientific work. It is on this account that we should urge the formation of a staff of permanently employed scientific investigators similar to the staff of the Geological Survey.

For in truth what that important State enterprise has effected for the economic exploration of the land of the British Islands is *mutatis mutandis* very much what has to be done for their seas. The parallel may indeed be pushed pretty far. For just as the deeper search for minerals, such as coal and iron—and even water—has now to depend on accurate geological knowledge when the resources of superficial prospecting are played out, so we may come to have to take seriously into account the conditions and place of production of the fish which we complacently content ourselves with hauling up in our nets. The Fishery Department has hitherto been in a tolerably chaotic state. But at any rate it summoned to its aid the most eminent biologist of the day. It would be an extraordinary anomaly if a carefully considered organisation discarded at starting the scientific help on which it will eventually have to rely.

ELECTRIC LIGHTING LEGISLATION

IT is not so many years ago that our only notion of practical electric lighting was the arc lamp. Experiments had indeed been made for many years (commencing as far back as in the year 1845) in the direction of incandescent lighting,—experiments where platinum and platinum-iridium wires had been made incandescent, where carbon in the form of sticks or pencils having very low resistance had been made incandescent. Indeed, King's experiments in the year 1845 had been made with the carbon pencil, and a proposition had been put forward for preserving these carbons from combustion by their use in closed vessels, in which either a vacuum was formed, or a preservative atmosphere, such as nitrogen, was introduced. But all these attempts at incandescent lighting were, as has been said, in a purely experimental condition, and the arc light was the only one in practical use.

At that time it was said that even if a satisfactory incandescent lamp could be made there was still, even for separate installations, the difficulty of dividing the electric current, and as regards anything like a distribution of electricity from a central source there was a further commercial difficulty in the great cost of the conductors suited to carry the needed current.

This state of things was followed by contradictory rumours of what Mr. Edison was doing in the United States. First that he had succeeded in producing a durable incandescent lamp; then that he had utterly failed; then that there was hope that he was about to succeed with the lamp, but he felt he must abandon any attempt to divide the current; and then similar contradictory rumours as to the possibility of supply from a central source.

At length, some six or seven years ago, it became undoubted that Edison had devised an enduring lamp, having a filament of high resistance; that the current could be readily divided to these lamps by placing them in parallel arc; and that, by the raising of the electromotive force to that needed for the working of the lamps, the mains could be reduced to within reasonable limits of cost.

After some little time had elapsed no doubt there was a very large amount of commercial speculation entered into in connection with electric lighting,—a most unfortunate thing for those who seriously desired its development, a most unfortunate thing for private persons who wished to adopt electric lighting.

The promoters of electric lighting had thought that, if they could show to Parliament they were prepared to undertake the lighting of a district, they would obtain the Parliamentary sanction needed in the case of railways, docks, water, gas, and other industrial undertakings, and under proper precautions granted by Parliament to those who were willing to subscribe capital. But at this point the Board of Trade intervened, under their then President, Mr. Joseph Chamberlain, and setting all precedent at defiance, obtained the passing of their Electric Lighting Act of 1882, an Act jocosely called "An Act to *facilitate* and regulate the supply of electricity for lighting and other purposes."

From the title of this Act any one would imagine that, while Edison had devoted years of his life to making electric lighting by incandescence possible, Mr. Chamberlain, appreciating these efforts, had stepped forward with a law which was to be generally applied; and that the labours of the statesman were to be in continuation of those of the philosopher in developing electric lighting. "Facilitate," on turning to Ogilvie's dictionary, one finds "to make easy or less difficult," "to free from difficulty or impediment."

Mr. Chamberlain's interpretation of the word "facilitate," as one gathers that interpretation from the 27th section of the Act, confirmed by four years' experience of its effects, is a very different one. "Facilitate" with him must mean "to make difficult or less easy," to "encumber with difficulty or impediment, or to add to it." The 27th section, which is set out *in extenso* in a footnote, may be briefly summarised as follows:—After the expiration of twenty-one years (or even a shorter period if the opponents can succeed in getting its insertion in a special Act), any local authority, corporation, or local board, or sanitary authority in whose district the undertaking is situated, may insist upon the undertakers selling to such authority the undertaking, and if they cannot agree as to the price, as, of course, they would not (for one does not agree in cases of confiscation), the value is to be determined by arbitration; but the value is only to be the fair market value oft he lands, buildings, works, plant, and material at the time of the purchase, but nothing is to be added in respect of "compulsory purchase," or of "good-will," or of profits, past, present, or prospective. Be it observed, however, there is no obligation on the part of the local authority to purchase if the concern does not pay at the end of twenty-one years. The local authority may forego the right to purchase. But then, still further to "facilitate" the investment of capital in electric lighting, the local authority at the end of a further seven years is again invested with the option, and so on from seven years to seven years.

At an interview between the parties something of this sort can well be imagined:—Mr. Town Clerk to the Chairman of the Company: "The end of the twenty-one years is coming, are you making a profit?" "We have begun during the last few years to pay a small dividend—3 per cent." "Oh! we can get 10 per cent. out of the extension of our gas-works. We sha'n't buy your electric light undertaking." The twenty-seventh year comes. Mr. Town Clerk and the Chairman again have an interview. By this time electricity has been appreciated; gas is going out of fashion, and the electric lighting shareholders are beginning to get some return for their years of labour, of no dividend, and of low dividend.

Chairman: "We made last year 7 per cent., and the year before 6."

Town Clerk: "Do you expect to continue 7 per cent. or do you think it will increase?"

"Well, we have now so many applications for the electric light in substitution of gas, that in frankness I must say I believe the dividend will not only be maintained but will be augmented, and within a few years will reach the maximum allowed."

"Thank you, Mr. Chairman. After the next council meeting you will receive a notice that the corporation intend to purchase your electric light undertaking, at the price of the materials, under the 27th clause of Mr. Chamberlain's Act!"

In fact, the local authority is by that Act put into the position of the big bully who tosses halfpence with the little boy, and makes him agree to "heads I win, tails you lose."

The Act provides that local authorities may themselves supply electricity for lighting purposes, and perhaps it may be said this was a real facility (a facility in the Ogilvie dictionary sense, and not in the Chamberlain dictionary sense). But has it been? Up to the end of last year it is believed not a single application had been made by any local authority to the Local Government Board in respect of a provisional order under this Act. The reason is clear. The local authority (and properly enough) does not wish to risk the ratepayers' money in that which may prove an unsuccessful adventure, and it says, "We'll wait until some company comes and does it—does all the pioneering, all the educating of the people to take a new source of light, runs every risk; and then if it turns out a failure, we shall have lost nothing; if it turns out a success, we'll acquire the right to make the profits for ourselves at the mere value of the then material," this being a value so small compared with the capital embarked that the revenue which would have paid only 5 per cent. on the capital invested will pay 10 per cent. upon the sum for which under Mr. Chamberlain's Bill the local authority will be entitled to acquire (we do not say "steal") the undertaking.

The Act, therefore, has proved not to "facilitate," in the ordinary sense of the word, the extension of electric lighting by local authorities; and is it surprising that (great as is the need of investment for capital with the hope of remuneration) it has been impossible to obtain money for private enterprise to develop electrical lighting by distribution from a central source with Mr. Chamberlain's 27th section staring the capitalist in the face?

When the Bill was in Committee, the maximum period allowed for enjoyment was not as long as twenty-one years, and the hardship upon investors having to give up their property at the end of the period was pointed out. The objectors were answered in this way, "Oh! you can charge such a price for your electricity that you will be able to get back your capital in the time allowed and earn a good dividend too." To this it was and is objected, that the great difficulty in spreading the business of electric lighting would be the competition with gas, and the low price to which it has been reduced by reason of private management and the sliding scale (of which more hereafter); coupled with the fact that the expense of supplying houses with gas-fittings had been incurred while a new outlay would be needed to furnish it with electrical fittings; so that it was impossible to hope for any custom at all if a high price were to be charged, which would prevent the chance of getting back capital by increasing the rate. It was also pointed out that any fixed period of purchase upon the terms of payment mentioned was prohibitory of practical working.

Suppose, for example, that £50,000 had been embarked in lighting a district, and that ten years having elapsed, the demand for electric lighting in the district was such as to need an increase of plant and mains, involving the expenditure of another £50,000. It is obvious that with only ten years' enjoyment remaining, no one would be insane enough to advance a shilling of this further capital; and this must be true, however extended the period of enjoyment might be, so long as the sum to be paid on acquisition is merely the value of the "then materials."

It may be asked, how came such an Act to be passed in the face of all these obvious objections? The answer is twofold. One, the growing and most mischievous tendency to make governing bodies into traders; the other, the fear of what might happen from having already made governing bodies, such as those of Birmingham, into traders. Local authorities had been stimulated to become the proprietors of gas undertakings, to risk the money of their ratepayers in a trade, in a highly artificial matter such as gas illumination. Under these circumstances, no matter at what sacrifice of the true principles of political economy, no matter what principles of ordinary fair dealing were abandoned, lighting by electricity must be so "facilitated" that it should never compete with local authority gas-works. No doubt it will be the same if local authorities ever make the plunge and adopt electric lighting; and if hereafter some one were to invent a practicable mode of storing up daylight and delivering it out at night (luminous paint to wit), then the Chamberlain of the day would obtain an Act to "facilitate" its use, which would be as efficacious as has been the "facilitating" Electric Lighting Act of 1882.

During the four years since that Act was passed, the public have become more and more alive to the merits of incandescent electrical lighting. Steamships, clubs, hotels, Inns of Court, and the mansions of the wealthy, are being lighted by separate installations, with a result in health, cleanliness, and convenience that must be experienced in order to be fully appreciated. This is all very well for the rich, but why are the poor, the tradesmen, or even the moderately well-off, to be debarred from the benefits of electric lighting? Why is the dressmaker's workroom or the shopkeeper's shop still to be lit by an illuminant which not only consumes the air, but gives out products of combustion intolerably heated, and charged with ingredients prejudicial to health, prejudicial to cleanliness, and destructive to books, paintings, and furniture?

In New York, where electricity has not been "facilitated," incandescent lighting has, during the last three years, been provided to all who cared to take it (and they are a very large number) who reside within a certain distance from a central distributing station. Why is that not to be allowed here? Why, in the present depressed state of trade, are not capitalists permitted to invest their capital upon the fair terms which have been allowed to every other industry, and thus give employment to thousands of operatives who are now out of work? Why are we to continue to use the gas from a ton of coal as an illuminant to obtain the light of 30,000 candles for one hour when the selfsame gas, driving an engine to produce electricity for electric lighting, would give us 50,000 candles for the same time. We are told we are to be debarred because of the fear of creating a monopoly, the truth being that this evil is permitted in order to maintain the monopoly which local authorities in certain towns have already got, and that must not be disturbed; while in the metropolis the effect of this Act is to foster the gas monopoly by preventing electrical competition.

It has been said that no other industry was ever burdened as electrical industry has been by the "facilitating" Act. The answer made to this statement before the Committee, and since, has been, "It is not so. Compulsory acquisition of a trading concern by the Government is no new thing."

There is Mr. Gladstone's Act of 1844, enabling the Government to purchase the railways; but what are the terms of purchase in this Act? At the end of a term of twenty-one years (see Section 2), notice to acquire might be given, but the payment was to be twenty-five years' purchase of the annual divisible profits on the average of the three preceding years, provided that the average rate should be less than 10 per cent; and further, mark this: "It shall be lawful for the company if they shall be of opinion that the said rate of twenty-five years' purchase of the said average profits is an inadequate rate of purchase of such railway, reference being had to the prospects thereof, to require that it shall be left to arbitration, in case of difference, to determine what (if any) additional amount of purchase money shall be paid to the said company."

In the case of certain of the Indian railways, the Government guaranteed 5 per cent. upon the money from the moment it was paid.

But the great instance relied on by Mr. Chamberlain was that of the Tramways Act of 1870. By virtue of this Tramways Act a company gets for nothing the actual surface of the road on which to lay its rails, to the great annoyance of all other traffic. The public require no education to ride in a tramcar; it appears upon the road, and the traffic begins at once. Although it may not be desirable, there is nothing revolting in the condition that at the end of twenty-one years the surface-soil should revert to the authorities on payment of the then value of the materials; but the Tramways Act has most carefully provided that the local authorities should not become traders in running tramcars. All that they can do, if they purchase, is to let the tramways on lease to other persons. The temptations, therefore, to acquire are not what they would be in the case of a successful electric light undertaking.

With respect to the bugbear of monopoly—this bugbear has been raised no doubt very largely by the mode of charging for water. On sanitary grounds it has been deemed expedient not to charge for water for domestic purposes according to the quantity supplied, but according to the ratable value of the dwelling in which it is used; and, under this provision, anomalies have arisen, and dissatisfaction has been felt, and the public, without examining the advantages, and without pausing to discriminate between the difficulties inherent to such a mode of charge, and the simplicity attendant upon a charge based on the quantity of the thing supplied, have rushed to the conclusion that every supply by a private company of that which is commonly used is an injurious monopoly involving the payment of more than a fair dividend upon the capital embarked. But recent legislation in respect of gas has entirely removed all reasonable grounds of objections such as these, and it has done so by the introduction of two clauses—the sliding scale clause already alluded to, and the auction clause.

The sliding scale gives a direct incentive to sell the commodity at the lowest possible price consistent with earning the dividend, because it provides that, as the price is diminished below the standard, the statutory dividend may be increased, while, if from any cause, such as a coal famine, the price is raised above the standard, the statutory dividend must be proportionately diminished. This great incentive to economy (benefiting alike the consumer and the shareholder) has entirely cured the supineness in the way of improvement that was fostered by the old condition of things, wherein the consumer was facetiously said to be "protected" by the fixing of a maximum dividend and a maximum price.

The other provision is one that thoroughly prevents the consumer from paying more than the fair market rate of interest needed to cover trade risks. That provision is known as the "auction clause." Under this clause all capital (after the first), instead of being allotted at par among the existing shareholders, must be offered to the public in suitable lots. By this means, if the rate of dividend allowed by the Act is deemed by the public to be more than sufficient to give a return, having regard to the trade risk, the public pay a premium for these shares. That premium goes into the capital of the undertaking, but bears no dividend. Thus the public are thoroughly protected against paying an undue rate of interest.

Having regard to all the foregoing facts, a Bill has been prepared on this very simple and intelligible basis —that electric lighting should be put on exactly the same footing as gas-supply: obligations to keep the mains always charged, to supply electricity on demand to any person wanting it on similar conditions to those which attend the obligatory supply of gas, the provision of a statutory dividend, a standard price, and a sliding scale, so as to give incentives to improvements benefiting alike the consumer and the shareholder, and the insertion of the auction clause for all future capital, by which the public are secured against paying an undue rate of interest.

This Bill—one so simple and fair in its character—has met with the thorough approval of Lord Rayleigh, who has now obtained a second reading for it in the House of Lords. No peer probably could with greater propriety take charge of a Bill relating to the practical application of electrical science. Lord Rayleigh's high position as a physicist marks him out as the proper person to bring forward such a Bill.

At the same time there are two other Bills before the House of Lords for the amendment of the Act of 1882. The first of these is that presented by Lord Ashford (better known as Lord Bury), the important section of which, the 6th, repeals the 27th section of Mr. Chamberlain's Bill of 1882, gives forty-one years as the period before the option of purchase arises, with recurrent periods of seven years, but provides that the purchase, whenever made, shall be upon the terms of paying the then value thereof as a going concern. The words prohibiting the arbitrator from taking profits into account are omitted, and the probability is that the arbitrator would be entitled to assess the value upon profits.

The second Bill is presented by Lord Houghton as representing the Board of Trade. The print of it has not yet been had, but it is understood to make no change in the objectionable features of the existing Act, but merely to add somewhat to the length of the term before the option of purchase arises. If this be so, it will still leave electric lighting as much "facilitated" as before, for there can be no increase of capital, and therefore no development, in an undertaking where, in a few years, the enjoyment of the interest upon that capital has come to an end, and where, when it does come to an end, a large portion of that capital will be confiscated.

Lord Houghton's Bill has this value, however—it shows, first, the length of time it takes the Board of Trade to admit they have made an error, and it shows, secondly, that it requires yet a still longer time to enable them to understand what that error is.

ELECTRO-DEPOSITION

Electro-deposition of Gold, Silver, Copper, Nickel; &c. By A. Watt. (London: Crosby Lockwood and Co., 1886.)

IN the preface of this book is stated:—"The author's desire was to furnish" "a comprehensive treatise, embodying all the practical processes and improvements which the progress of science has, up to the present time, placed at our command." "The author's aim has been to treat the more scientific portion of the work in such a manner that those who are not deeply versed in science may readily comprehend the chemical and electrical principles of electrolysis, the knowledge of which is essential to those who would practise the art of electro-deposition with economy and success." How far he has succeeded in his desire and aim, and to what extent the contents of his book are suitable to electro-metallurgists and agree with its title, it is our duty as reviewers carefully to examine.

The book is essentially and almost exclusively a workman's manual. In accordance with this we observe that out of about 568 pages, only about 18 are strictly devoted to the fundamental principles or foundation of the subject.

It is evidently written and compiled by a "practical" man who has spent a long period of time in electro-plate workshops. It has various excellences and defects, the most important of which we will endeavour to point out. Its chief excellence consists in the remarkable completeness of information given respecting the details of workshop manipulation, in describing the treatment of nearly every kind of article requiring a coating of electro-deposited metal. The author has with great industry and perseverance collected a large amount of such information, and his book is especially full of details respecting the electroplating of articles with nickel. The information contained in it is, with certain exceptions, well up to date, and the printer's errors are remarkably few. It has also the advantage of a copious index consisting of nearly 50 pp., and the subject-matter of the book is conveniently divided into chapters of moderate length, with the contents of each chief paragraph plainly indicated by bold headings.

Its greatest defects are those of omission; it is seriously deficient in the chemical, chemico-electric (*i.e.* voltaic), and electro-chemical (*i.e.* electrolytic) principles of the subject. Throughout the volume nothing is said respecting the fundamentally important matter, both theoretically and practically, of the chemical valency of the elementary substances; the chemical, voltaic, and electrolytic equivalents of those elements are also neither given nor explained. On p. 513 a table of atomic weights of the chemical elements appears, but as only a portion of these are equivalent to each other, and those not indicated, they would, without the valencies or a separate table of combining-proportions, in many cases only mislead an unscientific workman. The only indication of any difference existing between atomic-weight and chemical-equivalent is contained in a footnote to that table, saying, "the combining-weight of oxygen is 8."

From beginning to end of the book, the molecular and equivalent weights of all the compound substances employed in electro-deposition are omitted; none are given even for the commonest substances, such as sulphuric acid, potash, soda, lime, double cyanide of silver and potassium, blue-vitriol, potassic cyanide, double sulphate of nickel and ammonium, &c.; similar remarks may be made respecting the salts of zinc, cadmium, lead, tin, iron, nickel, copper, silver, gold, palladium, platinum, bismuth, antimony, &c.; also respecting hydrochloric, nitric, and other acids. Almost the only exception appears to be on p. 483, where it is said, respecting the salt used for making nickel-plating solution:—"The double salt consists of 1 atom of sulphate of nickel, 1 atom of sulphate of ammonium, and 8 of water."

Throughout the book also the chemical formulæ of all those compounds are omitted, notwithstanding that they would enable the workman to arrive in many cases at the chemical equivalents by comparing them with the atomic weights, and would also assist him to more perfectly realise and remember the actual chemical composition of the acids, bases, and salts used in his occupation.

In accordance with these omissions, no principle or general rule is supplied which will enable the operator to calculate how much in weight of a given metal or base would be necessary to neutralise a known amount of a particular acid, nor what quantities of acid and base would be required to form a certain weight of a salt, in making and correcting his various solutions; nor how much current would be generated by the consumption of known amounts of different positive metals or of different acids; nor what quantities of different metals would be deposited at the cathode, or of unlike ones dissolved at the anode, by the passage of a given amount of current through an electrolyte. Respecting this latter point, on p. 72 it is, however, stated:—"The decomposing effects produced by the voltaic current in different electrolytes are precisely in accordance with the *atomic-weights* or *chemical-equivalents* (which see) of the substances electrolysed." "For example, the same amount of electricity that would reduce 56 parts of iron from its solution to the metallic state, would reduce 207 parts of lead or 108 of silver." But the "chemical-equivalents" to which the reader is here referred are not to be seen in the book, nor does the table of "atomic-weights" necessarily indicate them; and either the above numbers given by the author for iron and lead are double the correct amounts, or that for silver is only half the proper quantity. This is an example of the misleading effect we have already referred to, of the table of atomic-weights, when unaccompanied by valencies or by one of combining-proportions, and used by a person unacquainted with the difference between atomic-weights and chemical-equivalents. The nearest approach to information respecting chemical-equivalents is indicated on p. 480, in instructions for testing the strength of potassic cyanide, but this is applicable only to the particular substances employed in the case. Any electro-depositor therefore who, relying upon the information contained in this book, wished to calculate the cost of depositing various metals, or to make experiments or improvements in his processes, outside the mere empirical or "rule-of-thumb" circle of knowledge, and involving chemical principles, would not be enabled to do so; in novel cases of difficulty in electro-deposition also, this deficiency of knowledge of chemical principles might prove a great disadvantage to him.

On p. 80 the writer says:—"It is necessary, in the present advanced state of electrical science, that both the student and practical operator should be acquainted with the principles and laws which govern the development of electricity;" and in the preface he speaks of "the chemical and electrical principles of electrolysis," "the knowledge of which is essential to those who would practise the art of electro-deposition with economy and success." But notwithstanding these statements, the important matters we have mentioned are omitted, and the student and practical operator are referred (pp. 80-90) "for a more intimate acquaintance with the principles of voltaic and dynamic electricity" to other books.

We observe that in Chapters V. and VI., on the theory of the subject, nothing is said about the thermal principles of electrolysis, or of the absorption and evolution of heat by chemical changes at the surfaces of the plates in voltaic and electrolytic cells. In the chapters on electro-deposition and electro-metallurgy of copper, the chemical analyses made by the Duke of Leuchtenberg (p. 395) and others, showing the composition of the insoluble matter of the anodes, are not given. The special defect of thermo-electric piles, viz. that they are only durable if kept at unvarying temperatures, is also not mentioned. And nothing is said of the presence of sulphur in electro-deposited "bright" silver. These, however, are much less important omissions.

The errors in the book are not many; we have observed the following:—"Nine parts of water consist of one part, *by weight*, of hydrogen, and eight parts, *by weight*, of oxygen; or by volume, 1 part hydrogen and 16 parts oxygen" (p. 74); the error is obvious. Roseleur says, "that solutions of cyanides, even without the aid of the electric current, rapidly dissolve in the cold, or at a moderate temperature, all the metals, except platinum" (p. 174); this statement of Roseleur's is not quite correct, iron is nearly as little dissolved as platinum, in a cold solution of pure potassic cyanide.

The author says that for containing cyanide of silver plating solution, "wooden tubs may be employed for small operations, but since that material absorbs the silver solution, such vessels should be well soaked in hot water before pouring in the solution" (p. 241). We may remark that such soaking does not prevent the wood becoming saturated with the silvering liquid.

On p. 270 it is stated that a solution of sulphide of potassium "dissolves" silver. This is not correct; it converts the surface of the silver into sulphide without dissolving either. On p. 365 the author speaks of "Chevalier Bunsen's methods" of electrolysis. We may state that the "Chevalier," and Bunsen the chemist, whose methods are referred to, are two different persons.

In various parts of Chapter XXX., on the electrolytic refining of copper, the author, speaking of where this process is in use, says:—"Besides Messrs. Elkington's works at Pembrey, South Wales," "by the Elliott Metal Refining Company at Selly Oak, near Birmingham, where Wilde's machines are employed." And under the heading of "Electrolytic Refining at Birmingham," he says:—"The Elliott Metal Refining Company, of Selly Oak, near Birmingham, employ five large Wilde machines, which refine about ten tons of copper per week;" and he then gives a variety of particulars respecting the arrangements employed, the "thickness of deposit" of copper per week at the "Selly Oak Works, Birmingham;" the "cost of electrolytic copper refining" at those and other works, based partly upon the cost of fuel "in Birmingham and Swansea," &c. (pp. 416, 420, 423, 424, 425). All this is founded upon a mistake; there is not, nor ever has been, any "electrolytic refining of copper," nor any plant for such a purpose, at "Selly Oak" or at "Birmingham," or anywhere near those places. This error appears to have been first published by M. Fontaine in his book on "Électrolyse," then copied by Berly in his English translation of that book, and again copied by Watt. The explanation and facts are: the Elliott Metal Company, of Selly Oak, near Birmingham, possess and carry on the Electrolytic Refining Works at Pembrey, near Swansea, formerly possessed by Messrs. Elkington.

The redundancies in the book are considerable; the following are examples:—Description of several voltaic batteries which are rarely used for electro-deposition, viz. Callan's, Walker's, Leclanche's, the bichromate, and Marie Davy's (pp. 11, 13, 15, 16); an account of Mr. Charles Watt's magneto-electric machine (p. 25); description and engraving of Mr. C. Watt's thermo-electric battery (pp. 42-45); the source, mode of collecting, and purifying gutta-percha (pp. 94, 95); gilding metals with gold leaf (p. 195); processes and compositions for colouring ordinary gold articles by chemical means (pp. 198-201); mercurial gilding, gilding bronzes with amalgam, ormolu (pp. 202-208).

A considerable portion of the book also is occupied by information which, although very useful to jewellers and other workers in metal, does not strictly belong to the subject of "Electro-deposition;" we allude to the following:—Driving-belts (pp. 487-493); gas-engines (p. 492); speed indicator (p. 497); characteristics of metals (pp. 498, 499); alloys (pp. 500-504); soldering metals (pp. 504-507); table of high temperatures (p. 515); tables of different wire-gauges (p. 517).

In various parts of the book, whilst there is an excess of details of manipulation, there are very few references to general principles, as if the main object of the author was to enable the workman to compensate for deficiency of knowledge of scientific laws by means of "rule-of-thumb" experience and by remembrance of a multitude of empirical instructions. In order therefore to enable the artisan reader to make the best use of the book, we would recommend him to previously learn sufficient of the principles of chemistry and of voltaic and electrolytic action, and then master the very numerous practical details of this book.

Repetitions of small matters are frequent in the book; in more than twenty instances the same statement has been made in modified forms, from two to four times. These repetitions are most frequent in the chapters on deposition of nickel.

In consequence of the considerable redundancies, the large amount of extraneous matter, the excess of details of manipulation, and the repetitions, a large quantity of matter might have been omitted, and the contents of the book would have been rendered more in accordance with the title. According to the present contents, a more appropriate title would have been "Manipulations in Electro-deposition," &c.

The writer of the book makes the following statement on p. 213; speaking of "cheap jewellery" he says: "The author has found it a very convenient plan to use a *copper* anode for gilding work of this description, and by making small additions of chloride of gold when the bath exhibited signs of weakness, he has been able to gild a very large number of articles of a very fine colour, with an infinitesimal amount of the precious metal. In his experience, although the prices were very low, the result was exceedingly profitable. Against the employment of a copper anode it has been argued that the solution must of necessity become highly impregnated with copper, to which we may reply that we did not find such to be the case in practice." The circumstance he mentions—that the solution "did not become highly impregnated with copper" is easily and correctly explained: the solution did become charged with copper, but not "highly," because the copper was deposited as fast as it was dissolved in alloy with gold upon the articles, and thus produced the "very fine colour," and conduced to the "exceedingly profitable" character of the result. A complete proof of this is afforded by the author on p. 197 of his book, in his instructions for depositing alloys of gold.

On p. 214 he very truly remarks: "The introduction of the electro-gilding art greatly favoured such unscrupulous persons as desired to prey upon the public by selling as gold, electro-gilt articles which had not a fraction of the precious metal in their composition." As an example of this he mentions "mystery-gold," and states that "the chief aim of the manufacturers" of articles made of that composition "is to defraud pawnbrokers."

In Chapters XXIX., XXX., and XXXI., on "Electro-metallurgy," the author has copied and collected together, from Fontaine and Berly's books on "Electrolysis," and various periodicals, &c., nearly all the information yet published respecting the electrolytic refining of crude copper, lead, zinc, &c., on the commercial scale, and the economic extraction of metals from minerals by the aid of electrolysis. Six pages of those chapters are devoted to a description, with drawings, of Cowle's electric furnace. But this furnace is not "electrolytic": it is one in which an intense heat is obtained by means of the electric arc on a large scale in an inclosed fire-resisting chamber, in which carbon at an enormous temperature reduces aluminium and silicon from their oxides, and those reduced elements form alloys with copper previously mixed with the carbon. Much of the information contained in these chapters is useful, but a large portion of it relates to new processes, and partly unsuccessful experiments on a large scale; and as some of those processes are imperfect and in a state of development, the statements made respecting them should be received with caution.

In consequence of the serious deficiency of information respecting the chemical, voltaic, and electrolytic principles of the subject, we do not consider that the author has succeeded in his aim "to treat the more scientific portion of the work in such a manner that those who are not deeply versed in science may readily comprehend the chemical and electrical principles of electrolysis." But notwithstanding the fundamental and minor defects which we have pointed out, as the details of workshop information and manipulation contained in the book are so copious and complete, we think he has substantially attained his "desire to furnish a comprehensive treatise embodying all the practical processes and improvements in the art of electro-deposition"; and, irrespective of its shortcomings, the book will prove of great value to many electro-depositors, jewellers, and various other workers in metal.

OUR BOOK SHELF

"Weatherology" and the Use of Weather Charts. By Campbell M. Hepworth, R.N.R. (London: Laurie, 1886.)

METEOROLOGISTS must wish success to this endeavour of Capt. Hepworth's to popularise their technical phraseology, and to explain how the public can utilise the weather-charts which appear daily in the *Times* and *Lloyd's List*, in combination with local observations of wind, sky, and weather. The author has considerable sea experience in the North and South Atlantic, and he imparts the results of it freely, but his language is still rather too scientific for an ordinary reader.

Without being hypercritical, we must take exception to two statements. The definition of a "gradient" is defective, for no mention is made of the unit of barometrical difference (0·01 inch), which is employed, while the modern unit of distance is 15 miles, not 60.

Again we must protest against fathering on Admiral FitzRoy (p. 5) the form of siphon barometer which is sold for a guinea, and sometimes is called after him, sometimes dubbed the "Polytechnic barometer." There is no authority to connect the Admiral with it, as either inventing or even approving of it.

ROBERT H. SCOTT

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Residual Magnetism in Diamagnetic Substances

IN the account which Prof. Lodge gives of his very interesting experiments (NATURE, March 25, p. 484) he describes an observation which at first sight seemed to show the existence of residual diamagnetic polarity in a diamagnetic substance after exposure to a strong field, and remarks that this seemed an incomprehensible result. It appears to me that this result, should it be confirmed, is not incomprehensible on Weber's theory of diamagnetism, if we supplement that by a modification of the Ampère-Weber theory of ordinary magnetisation.

Suppose that the induced currents in the molecules of a diamagnetic substance are confined to definite channels, that there is little or no primitive current, and that the molecules are capable of being deflected. Then as the field is increased, each molecule is turned so that the plane of its channel becomes more and more nearly parallel to the lines of force. We may assume that this turning of the molecules is resisted, like the turning of the molecules of iron, and that when the field is withdrawn they return more or less completely towards their initial positions.

Experiments with iron and steel show that in the turning of the molecules the resistance while the field is being applied is on the whole greater than the restoring force, while the field is being removed: in fact something very like static friction acts on each molecule. There is what I have elsewhere called "hysteresis," or lagging behind, in the relation of the molecule's movement to the magnetising force. If this molecular quasi-friction also exists in diamagnetic substances, and if the molecular channels are turned at all, they will, during the removal of the field, be in less favourable positions for the induction of currents than they were in during the application of the field. There will consequently be a residue of current in each when the field is wholly withdrawn; and these residues will make the substance a permanent "diamagnet."

But the fact that this result would be comprehensible is no evidence of its truth, and apparently Dr. Lodge inclines to interpret the experiment referred to in an entirely different—indeed opposite—sense. Moreover, his other results show not residual *diamagnetism*, but residual *paramagnetism* in diamagnetic substances which have been immersed in a very strong field.

Now I think this result may also be interpreted in terms of the magnetic theory of magnetisation; and the purpose of this communication is to suggest an explanation which seems to me so probable that it may perhaps serve, until Dr. Lodge confirms these results, as a set-off against the suspicion he has cast on them by suggesting the presence of iron in his diamagnetic bodies.

When we begin to magnetise iron by a field which increases from zero, we find at first scarcely a trace of magnetisation. A curve showing the relation of intensity of magnetism to magnetising force starts off (as nearly as can be judged) tangent to the line along which the magnetising force is plotted, but soon, of course, takes a rapid bend as the permeability increases. This is very consistent with the idea that the molecular electromagnets are held back from turning by a sort of static friction which requires the field to reach a finite value (different perhaps for different molecules) before the process of turning begins. But what has happened before this process begins? Diamagnetic induction has been going on in each molecule that has not begun to turn; and hence, if the molecular configuration is rigid for a magnetising force of any finite magnitude, the substance is diamagnetic in that and all weaker fields.

If this be the case in iron (and the experimental evidence certainly points to the existence of a finite frictional resistance to the turning of the molecules) that metal is really diamagnetic in excessively weak fields, because the molecules are fixed by friction; then very paramagnetic in stronger fields, because the molecules are turning; and, finally, diamagnetic in a field strong enough to turn the molecules as far as they will go, and to induce currents in them which swamp the primitive Ampèrian currents.

Next, imagine a substance whose molecules are held by friction in a very tight grip, so that no moderate magnetising force is able to alter their configuration. The substance is then diamagnetic, and when the field is withdrawn there is no residual polarity. But let a field be applied strong enough to begin turning the molecules. This will cause a decrease of diamagnetic susceptibility. And when the field is withdrawn the molecules remain deflected, and the substance is a permanent *paramagnet*.

Now this is exactly what Dr. Lodge has observed in his copper, coke, wood, and so forth. They behaved as diamagnetics while in the field, but showed paramagnetic polarity when withdrawn from it.

My suggestion, then, is that in diamagnetics, as in paramagnetics, there are strong primitive Ampèrian currents circulating in the molecular channels. That in a strongly paramagnetic substance such as iron there is comparatively little molecular rigidity, so that the molecules begin to turn even in very weak fields; the induction of currents in their channels then plays a very insignificant part in the magnetisation. That in a diamagnetic substance, on the other hand, the molecules stick so fast that in any moderate field they have scarcely begun to turn; the induction of currents goes on independently of the existence of the primitive currents, and is then practically the whole affair. But if the field be made strong enough the molecules begin to turn, not in the way spoken of in the earlier part of this communication (where it was assumed that the induced currents swamped the primitive currents), but in the way in which the molecules of iron turn. Then common magnetisation becomes superposed on diamagnetic induction. And when the field is withdrawn the molecules are left with a paramagnetic alignment, and with their primitive Ampèrian currents strengthened, if anything, since they have been facing more favourably during the withdrawal of the field.

There is nothing to show that the primitive Ampèrian currents are not as strong and as numerous in copper or bismuth as in iron. If they are, and if we could only apply a field strong enough to force them into alignment, we might expect to find, in substances so hard to magnetise, a permanence in the residual magnetism which would put steel to the blush.

University College, Dundee, March 27 J. A. EWING

Ferocity of Rats

I HAVE recently had occasion to chloroform a number of wild rats for the purpose of procuring their blood. The rats are sent to me by a ratcatcher, who places from six to twelve in the same trap or cage. It usually happens that, within a few hours after their imprisonment, some of their number are killed and eaten by the others; while they all exhibit scars as the result of their struggle for existence in confined quarters.

A few days ago I placed two wild rats in a cage, and for a long time endeavoured unsuccessfully to catch the larger one under a bell-jar let in through a doorway in the top of the cage. The rat perfectly well understood my object, and for about ten minutes succeeded by his agility in thwarting it. This animal, therefore, must have been in as great a state of alarm as it is possible that a rat could be. Nevertheless, after the ten minutes' chase inside the cage—during which he had been many times very nearly caught—he appeared to be suddenly seized with a violent outburst of ferocity against his fellow-prisoner; for he fell upon the smaller rat, drove it into a corner of the cage, and killed it by biting its throat. By means of a glass rod I drove him away, drew the dead body of his victim beneath the doorway in the roof of the cage, and held the bottom of the bell-jar just above the dead rat. I had not long to wait before the living one again fell upon his victim and began to devour the carcass. It was then an easy matter to lower the bell-jar over both the living and the dead, when, by pouring chloroform in at the open top of the bell-jar, I quickly reduced the murderer to a state of insensibility. But up to the very last moment of consciousness this animal continued to bury his fangs in the body of the little rat, and even after his head had dropped away in stupor the jaws still continued to move as if he were enjoying the feast in his dreams.

Now, I do not believe that any instance of ferocity at all approaching this could be found in any other animal. But it has been suggested to me that the fact may have been due to a kind of emotional insanity produced by extreme terror. I therefore write to ask whether any of your readers can supply me with additional facts bearing upon the subject. In particular, is it the habit of wild rats when not confined, or when in a state of nature, to devour one another? Or do they only do so when shut up together in a cage? GEORGE J. ROMANES

The Recent Weather

THE enclosed extract from the log of one of the "excellent" observers for the Meteorological Office may be interesting to some of your readers, as bearing upon the large amount of easterly winds and severe weather which were experienced at the time. HENRY TOYNBEE, Marine Superintendent

Meteorological Office, London, March 27

Extracts from Meteorological Log of the Ship "Timaru," Capt. D. Fullarton

1886 March 15; Noon Position, Lat. 48° 31′ N., Long. 8° 16′ W.

"A great many small land birds about us; put about 60 into a coop, evidently tired out."

1886 March 17; Noon Position, Lat. 48° 30′ N., Long. 7° 34′ W.

"Over 50 of the birds cooped on the 15th died, though fed. Sparrows, finches, water wagtails, two different small kinds of birds, names unknown to me, one kind like a linnet, and a large bird like a starling. In all there have been on board over 70 birds, besides some that hovered about us for some time and fell into the sea exhausted."

Variable Stars

I HAVE to express my indebtedness to Mr. Castell-Evans (NATURE, March 25, p. 486) for drawing my attention to Prof. Meldola's valuable memoir of 1878. Occasionally I cannot help passing over a paper of great interest; and, much to my regret, I did not read Prof. Meldola's until to-day. According to his theory there is ". . . actual combustion taking place in the atmosphere of a slowly-cooling star previously at a temperature of dissociation." The previous existence of elements is assumed throughout the memoir; and it is these which undergo "actual combustion," and of course give rise to compounds capable of the dissociation referred to. Prof. Meldola proceeds to show that dissociation of compounds and actual combustion of elements may very well lead to a "periodically unstable chemical equilibrium."

For my part I was not writing about combustion, but about polymerisation; not about compounds, but about elements; and nothing was said about dissociation. Chemical effect, moreover, was expressed by an equation totally different in form from dissociation equations.

There is thus a perfect distinction between my work and that of Prof. Meldola. He is, so far as I am aware, the originator of the theory that the variability of a star may depend on actual combustion of elements, followed by dissociation of compounds. I regard this theory as having considerable value, and great probability. But it has obviously nothing whatever to do with my own. EDMUND J. MILLS

Glasgow, March 27

Colours in Clouds

I AM afraid I cannot give any further details to aid Mr. Backhouse. My object was to point out that the presence of coloured fringes is not very rare, though they require suitable means to see them.

I do not think the dark blue tone is very material. Mr. Backhouse will, however, see that it implies a general absence of glare and illumination of the atmosphere in the neighbourhood of the cloud, and that is exactly the condition which I artificially made by a suitable dark glass, which stopped the glare. It is the dilution of the tints with white light which makes them faint or invisible. Of course it may be said that the dark glass will weaken the tints as well as the general light, but as a fact the tints do show better through a proper one, and reduction of glare does make colour more marked.

Nor do I think that the square or rhomboidal form is important, for I think that is only the result of the air-currents which cause the light cloud.

These colours will be oftener seen in projections from banks near the horizon, if my view be correct of the height at which they are formed, because it is only when the bank or mass of thick cloud hiding the sun is low that we see well above it. Mr. Backhouse gives enormous heights at which water could only visibly exist as minute ice-crystals, such as cause halos. J. F. TENNANT

37, Hamilton Road, Ealing, W., March 27

The Distribution of Appendicularia

IN regard to Prof. Herdman's query concerning the distribution of *Appendicularia* it may be mentioned that this form was frequently met with near the surface of the sea during the observations for H.M. Trawling Commissioners along the east coast of Scotland. From previous observations it would seem to be prevalent, especially in summer and autumn, all round our shores, as well as to stretch far into the neighbouring seas. W. C. McINTOSH

St. Andrew's Marine Laboratory, March 23

THE TECHNICAL INSTITUTE

IN considering the sixth Annual Report of the Council of the City and Guilds of London Institute to the Governors, we cannot but be impressed with the substantial advance made in each of the several branches of the Institute's work.

The past year has seen the completion of the great Central Institution in Exhibition Road, the University of the system of technical education, and London may be congratulated on at last possessing an institution which is, as pointed out in the Report, comparable with, and in some respects superior to, a German Polytechnic School. Considering the thorough manner in which the workshops and laboratories in the several departments have been equipped, we think the Institute is justified in claiming that parents will be enabled to secure in England for their sons technical instruction of the same high class as has been for so long provided in the great technical colleges abroad, and moreover better adapted to the special circumstances of home industry. The Report further expresses a patriotic hope that students trained in the Central Institution will gradually occupy the places in manufacturing works, and especially in chemical works, both in Great Britain and the colonies, which have of late been almost monopolised by the Germans and Swiss.

Besides the regular courses of instruction, special series of lectures are given by the Professors of the Institution at 5 o'clock, and we have reason to know that such courses as Prof. Henrici's on the Differential and Integral Calculus for engineering students, and those by Prof. Armstrong on Carbon-Compounds, and by Prof. Ayrton on Industrial Applications of Electricity, now being given, fulfil a distinctly-felt want. The same may also be said of the special courses, including that on Iron-Girder Bridge Construction, by Prof. Unwin, to be given in July.

At the Finsbury Technical College the year has been marked by the appointment of Dr. Silvanus Thompson to the office of Principal, a post the duties of which have hitherto been discharged by Mr. Philip Magnus, the Director and Secretary of the Institute, but which the enormous increase in all the branches of the Institute's work has compelled him to relinquish. It is satisfactory to note that the great success already achieved by this College, both with respect to its Day and Evening Departments, has continued, and the Institute has determined to considerably increase the accommodation at a cost of 17,500*l*. In the Evening Department greater prominence has been given to courses of instruction for persons engaged in the various branches of the building trade, laboratories for instruction in plumbing, in gas-fitting, and in metal-plate work having been arranged, as also a class for builders' quantities. There are now between 600 and 700 persons attending the courses in the Evening Department.

The branch of its work by which the Institute is most widely known, the system of technological examinations, develops rapidly. According to Mr. Magnus's present Report, 3968 candidates presented themselves for examination in May last, of whom 2168, or nearly 55 per cent., were successful in passing. Examinations were held in forty-two subjects. In four subjects included in the programme, viz. salt manufacture, oils and fats, silk manufacture, and mechanical preparation of ores, the number of candidates was below the minimum for which an examination is held. In regard to silk manufacture, Mr. Magnus, in deploring the want of attention given in this country to technical instruction in connection with this important industry, points out the great improvement which has taken place in the silk trade of Crefeld as a result of the establishment of the Weaving and Dyeing School at that place.

Examinations were held for the first time, in 1885, in boot and shoe manufacture and in framework knitting, at which a number of students from the new Technical School at Leicester presented themselves.

It is satisfactory to observe that great attention continues to be paid to making the examinations of such a character as to prevent students possessed only of mere book-knowledge from passing. Practical examinations were held in weaving and pattern designing, in metalplate work, in mine surveying, and, for the first time, in carpentry and joinery. In all these subjects (except mine surveying), candidates have to send in specimens of work duly certified as having been executed by themselves.

The examinations were held in 167 towns in Great Britain and Ireland, Manchester heading the list of provincial towns so far as regards the number of its successful candidates. The Polytechnic Institution, London, was equally successful, and next in order came Bradford, Leeds, Bolton, and Huddersfield.

With regard to the prospects of the examinations in May of this year, it appears from returns furnished in November last that 6396 persons were receiving instruction in the registered classes of the Institute, as against 5874 in the previous year; and it may therefore be expected that a considerably increased number will present themselves this year.

It must be gratifying to the Institute to have received an application, recently noticed in these columns, from the Board of Technical Education in New South Wales, to extend the examinations to that colony, and we are glad to observe that the Council of the Institute, believing that whatever tends to unite more closely the colonies with the mother country is calculated to improve their mutual trade and commerce, recommend that the application should be acceded to.

The annual meeting of the Governors was held yesterday, under the presidency of Lord Selborne, who delivered an address on the work of the Institute during the past year.

EXHIBITION OF BAROMETERS

THE Royal Meteorological Society held its seventh annual Exhibition of Instruments on March 16 and 17, in the Library of the Institution of Civil Engineers, 25, Great George Street, Westminster. The Exhibition was devoted entirely to barometers, with the exception of a few new instruments which have been brought out during the past year. A very valuable collection of different forms of barometer was brought together, and in those cases where it was not possible to obtain a specimen of the instrument a photograph or illustration of it was shown. The Exhibition therefore practically included almost every known form of barometer.

The instruments were classified under the following headings:—Mercurial Barometers: Adjustable Cistern, Closed Cistern, Siphons; Barographs; Aneroids; Metallic and other forms of Barometer. There were altogether 78 barometers, 9 new instruments, and 33 drawings, photographs, &c., making 120 exhibits.

Some very fine specimens of standard barometer on the Fortin principle were exhibited—Mr. P. Adie showing one with a glass plunger to raise the mercury in the cistern, Mr. Casella showing another with the scale figured to tenths of an inch, and Messrs. Negretti and Zambra showing a third with cistern and tubular casing square in section. By the side of these were placed a portable barometer, with ivory float, about 100 years old, and a standard barometer, by Barrow, the pattern used by the members of the British Meteorological Society about 1850-60. Messrs. Negretti and Zambra exhibited a self-compensating barometer with a double rack moved by one pinion, so that, when adjusting the vernier in one position, the second rack moves in the opposite direction, carrying along with it a plunger, which is the exact size of the internal diameter of the tube. This firm also showed a standard barometer with electrical adjustment, and a new standard barometer with overflow cistern adjustment. Some interesting specimens of mountain barometers were exhibited, including one originally used by the North American Boundary Commission in 1857, which since its return has been employed by the Kew Committee on the inter-comparison of the various standard barometers of this country.

Among the closed cistern barometers was the large cistern one made for the Meteorological Society of London in 1837 by Mr. R. C. Woods. The proportion of the calibre of the tube to that of the cistern is as 1 : 50, a proportion which was considered sufficient to obviate the necessity for applying capacity corrections. The tube and cistern originally held 70 lbs. of mercury! The next instrument to this was the Kew barometer, first designed in 1853, in which the cistern is closed and the scale contracted so as to obviate the necessity of correction for capacity. Specimens were exhibited of the marine barometer, as supplied to Her Majesty's ships previous to 1854; the Kew marine barometer, as adopted by the Admiralty; the gun barometer, with the glass tube packed with india-rubber to check the vibration caused by firing; and the coast barometer. The Meteorological Office showed patterns of barometers as used in France, Holland, and Russia. Two specimens of long-range barometer were exhibited, viz. Morland's diagonal, by Messrs. Negretti and Zambra, in which the top part of the tube is inclined more or less from the perpendicular to give an enlarged scale-reading; and Hicks's spiral tube, which gives a range of 8 inches for 1 inch variation of atmospheric pressure.

Among the siphon barometers were two very old forms, viz. Hooke's double barometer and a Dutch barometer, by Reballio, combining siphon and long-range barometer, thermometer, and hygrometer. An interesting relic was the mounting of the travelling-barometer formerly belonging to, and used by, De Luc. The siphons included Gay Lussac's, Bunten's, Jones's, Adie's, Dollond's, Bogen's, and Wild's forms of barometer; also a siphon designed by Capt. J. B. Basevi, R.E., and used by him in the high table-lands of Tibet, in connection with the operations of the Great Indian Trigonometrical Survey; Stanley's barometer, with "rising and falling" index; and Guthrie's sensitive barometer, which has a flat horizontal spiral in which is a bubble of air for indicating the variations of atmospheric pressure, the motion of the bubble being four and a half times that of the true barometric variation.

A specimen of Milne's barograph was shown by the Meteorological Office, while Messrs Negretti and Zambra exhibited their improved form of the same instrument in which the paper is carried on a cylinder. MM. Redier, of Paris, sent two forms (large and small) of their barograph, which works so satisfactorily; and MM. Richard Frères, of Paris, in addition to sending a self-recording mercurial barometer, exhibited several specimens of their self-recording aneroid, which is becoming so popular in this country. This instrument consists of a series of eight vacuum-boxes, by which the effects of the atmospheric pressure are increased and transmitted by a system of levers to an arm carrying a pen. The pen, of a special form, contains an ink mixed with glycerine, and marks the curve of atmospheric pressure on the paper round the cylinder, which revolves once in seven days. This firm also showed a Bourdon's metallic recording barometer, in which the drum turning in eight days is supplied with a continuous band of paper, serving for six months or a year.

Various specimens of aneroids were exhibited, including skeleton aneroid, showing the various working parts; aneroid with altitude scales; pocket watch aneroid, indicating heights to 20,000 feet; Stanley's surveying aneroid; Field's engineering aneroid; aneroids as supplied to Her Majesty's ships previous to 1854, and the pattern now adopted; and self-registering aneroid with maximum and minimum indexes. Messrs. Lund and Blockley exhibited a barometer dial 6 feet in diameter, the hand of which is kept in its true position by a single aneroid vacuum-box.

Mr. Stanley showed his chrono-barometer, which is a clock that counts the oscillations of a pendulum formed by a suspended barometer. The upper chamber of the pendulum is a cylinder of an inch or more in diameter. By change of atmospheric pressure the mercury in the pendulum is displaced from the bottom to the top, and *vice versâ*. The rate of the clock is accelerated or retarded in proportion to the displacement of the mercury.

Among the other forms of barometer were Jordan's glycerine barometer, the cistern and upper part of the tube only being shown, as the instrument, when complete, would be about 30 feet in height; Cetti's long-range mercurial and glycerine barometer; Hicks's flexible barometer; Lowne's handy weather-glass; Ronketti's thermo-barometer; Wilson's differential barometer; and several patterns of sympiesometer.

The most interesting of the new instruments was Immisch's pocket metallic thermometer. This is a watch-shaped instrument, and about the size of a small locket. The index-hand is actuated by the expansion and contraction of a very small Bourdon tube filled with a highly expansive liquid, and hermetically sealed, the motion of the tube being multiplied by an ordinary rack and pinion.

SONNET

To the Savilian Professor of Astronomy in the University of Oxford, Author of a Memoir on the Proper Motion of Forty Stars in

THE PLEIADES,

On his receiving the Gold Medal of the Royal Astronomical Society for his Investigations of the Relative Brightness of the Fixed Stars

PRITCHARD! thy praise is lifted to the skies,
Who in the starry fields find'st pure delight,
Noting each ray that gilds the brow of night
From pale gems set in depths beyond surmise.
Press on, where Fame's sublimest summits rise-
Time's stroke falls lightly on his sacred might
Who ploughs from morn to eve his furrow right
Then sinks to rest 'midst sunset's gorgeous dyes.
Hail! faultless herald of the bright-eyed throng
Heir to the wand, once Tycho's, to assign
What place and precedence to each belong:
Whilst yet with watery ray yon Pleiads shine
Or strew with sands of gold their hair divine,
Thy name shall flourish in immortal song.

NOTES

HER MAJESTY THE QUEEN has been pleased to intimate her intention of opening the Colonial and Indian Exhibition on Tuesday, May 4.

M. VULPIAN has been elected by a majority of one over M. Alphonse Milne-Edwards, Permanent Secretary of the Paris Academy of Sciences, in the place of the late M. Jamin.

THE death is announced of Mr. Charles George Talmage, F.R.A.S., on Saturday. He was director of the private observatory of Mr. J. G. Barclay, at Leyton.

THERE has recently died in Calcutta one who, though not in any sense a man of science, has done much for science as an artistic delineator. A Belgian by birth, Jules Schaumberg more than twenty years ago found his way to India, in search of the picturesque, and was at first associated with M. Rousselet, author of "Les Indes des Rajahs," during which time he made many admirable sketches and water-colour pictures illustrative of the architecture and life in the cities of Central India. His capital having been exhausted, he accepted an appointment as artist in connection with the Geological Survey of India. The number of plates drawn by him for the Survey and also for the *Journal* ot the Society amount to hundreds, and those who knew Schaumberg well remember the interest and spirit he threw into the drawing of plates representing animated life. He lately officiated as Principal of the Bengal School of Art, and died suddenly at the age of forty-six.

THE Biological Section of the Canadian Institute of Toronto proposes to petition the Dominion Government to reserve one of the islands in Lake Superior for the preservation of native Canadian animals.

MR. EDGAR HALL, of Queenborough, sends us a cutting from the *Sydney Echo* of February 4, giving an interesting account of a vessel which is reported to have been set fire to by a meteor. The vessel, a schooner, the *J. C. Ford*, was on her voyage from the Pacific Coast to Kahului, Maui, and the communication originally appeared in the *Pacific Advertiser*, published at Honolulu. The letter is dated "Kahului, Dec. 22, 1885," and addressed to the Hon. S. G. Wilder. It is signed "T. H. Griffiths, captain; B. J. Weight, passenger." On Saturday, Dec. 12, according to the letter, being in latitude 23° 53′ N., longitude 143° 26′ W., at 1.30 p.m., the weather being fine and wind moderate, the first mate, Mr. Mercer, discovered the mizen-staysail, which was clewed up, to be in flames at the mainmast-head. With all possible speed the fire was put out by means of water, beating, and cutting away. "It is needless to say that all hands wondered at a fire occurring at the mast-head, but the finding of fragments of some metallic-like substance showed us that something of a meteoric nature was the cause. Those on the deck were picking up burning fragments and throwing them overboard. The pieces of the strange substance were found at the base of the mainmast. A piece as large as a man's hand was thrown overboard quite hot by Mr. Weight, and a piece as large, or larger, which was burning the mainsail, was thrown overboard by one of the hands. The above are the facts, as we remember them, and as they are recorded on the ship's log. In the night previous the weather was clear, but meteors were very numerous, and the mate and man at the wheel noticed their frequency and numbers, and also that they would burst in a manner resembling a rocket. No shock was noticed, the first intimation of the occurrence being the staysail in flames. Our theory is that the substance found is the crust of a meteor or fragment projected laterally. As there was a large quantity of kerosene and other combustible matter on deck, there were doubtless more than the two pieces thrown overboard in our anxiety to avoid disaster."

A PRIZE of 25,000 francs, or 1000*l*., is offered every year by Leopold II., King of the Belgians, for the best essay on some predetermined subject tending to advance the well-being of mankind. The competition is alternately restricted to Belgians and thrown open to the whole world, being settled by an international jury. The subject of this year's competition, open to the whole world, was "The Best Means of improving Sandy Coasts"; and the prize has been awarded by an international jury, including some of the most eminent English and French engineers, to M. de Mey, Engineer of Ponts et Chaussées, Bruges, against fifty-nine competitors. The subject for the essay at the next international competition is "The Progress of Electricity applied to Motive Power and Illumination, its Applications and Economical Advantages." The essays for competition, which must be written in French, or translated into that language, are to be sent before January 1, 1889, to the Minister of Agriculture, Industry, and Public Works, from whom the conditions of the competition may be obtained.

BOTANISTS will be pleased to learn that the "Flora of the West Riding of Yorkshire," which Dr. F. Arnold Lees has been engaged on for some years, will shortly be ready for the press. It will be a complete and comprehensive enumeration of species in all the groups, phanerogamic and cryptogamic, which occur in the wide and diversified area of which it treats, together with chapters on lithology, climatology, bibliography, &c. The account of each plant will include its range, horizontal and vertical, and its history as a West Riding species. The work is to be issued by subscription under the auspices of the Yorkshire Naturalists' Union, and will constitute an important volume of their series of memoirs dealing with the flora and fauna of Yorkshire.

THE Sheffield Free Library Committee can report a greatly increased use of the specifications of patents in the Reference Library as well as of the books of the Science and Art Class. The issue also of works of fiction in the circulating departments has also fallen off, while that of history and travels and arts and sciences has increased in both central and branch libraries. Of this, however, the Committee may probably take much of the credit, as they have not only spent a larger amount of money in the more valuable books, but have also purchased a larger number of volumes. The value of branch libraries is shown by the result that three in Sheffield have scarcely reduced the average issues of the central one; and if, in a place of so great a rental, further progress is crippled for lack of funds, how highly necessary must something beyond a penny rate be in many towns only a small fraction of its size. Although during the past year the Observatory was open only thirty-seven nights, yet the Committee report that its "utility is confirmed by experience."

A LIONESS's brain was recently dissected and studied by Herr Familiant at the Anatomical Institute of the Berne Veterinary School. Among other results he finds (*Mittheilungen* of Berne Naturalists' Society, 1885) that in form it is in many respects intermediate between the dog's and the cat's brain; from both it is distinguished by relatively small projection of the cerebellum and narrowness of the *lobus pyriformis*. Further, the chief fissures of the brain of carnivores are to be found in that of primates, the principal differences between homologous fissures being partly in imperfect formation or perhaps retrograde formation of certain parts, and partly in confluence of some sections of originally separate fissures. In some varieties of the fissuring of man's brain, the original relations of the carnivore's brain recur. The parieto-occipital fissure is a special formation not met with in the brain of carnivores. The secondary fissures, especially in the frontal lobes, are due to a special mode of fissuring that has appeared late, and is therefore subject to wide variations.

ARCHÆOLOGISTS are placed under fresh obligations to Dr. A. B. Meyer, the indefatigable curator of the Dresden Natural History Museum for his recent publications on the prehistoric settlements and graveyards of Gurina in Karinthia and of Hallstadt in Upper Austria. Since about the middle of the century, Gurina, which lies on the Upper Gail, an Alpine stream flowing to the Drave above Klagenfurth, had been vaguely spoken of in connection with a few stray antique objects from time to time falling into the hands of collectors. But the very locality of the place was scarcely known until, one of these objects coming in the way of the author, he was induced to visit the neighbourhood during the summer of 1884 on behalf of the Viennese Anthropological Society. Although able to do little more than "scratch the surface," he was soon convinced that Gurina must have been an important centre of European culture, either Etruscan or more probably Illyrian, some centuries before the new era, consequently that a systematic exploration of the locality is urgently demanded in the interest of archæological science. The results of his own preliminary investigations are embodied in an elaborate monograph, entitled "Gurina im Obergailthal" (Dresden, 1885), which also contains a full account of all the interesting finds hitherto made and here figured on fourteen admirably executed photographic plates. Although mostly picked up accidentally without any systematic research, these finds are of the most varied character, including Greek (Alexandrian), Roman (Imperial), Keltic (?), and other barbaric coins in silver, bronze, copper, and brass; bronze and iron fibulæ, iron chains, bronze chains and plaques, bronze and tin statuettes, iron swords and knives, glass ware, potsherds plain and ornamented, and other artistic remains, some apparently of local manufacture, some introduced from Greece, Italy, Gaul, and other countries during a period ranging from perhaps 200 or 300 years before to as many after the new era. Amongst the most interesting objects are the bronze plaques, pins or bodkins inscribed with Etruscan or Illyrian characters, a few words of which have been deciphered and referred by Paoli to the Illyrian branch of the Aryan linguistic family. The Illyrian (Thraco-Illyrian) peoples would seem to have reached their extreme western limits in this part of Noricum, where they came in contact with the Etruscans and Kelts, and were ultimately absorbed in the Roman Empire.

ON his return from Gurina, Dr. Meyer made an excursus to the prehistoric necropolis of Hallstatt in Upper Austria, an account of the past and present state of which he communicates in a short memoir, "Das Gräberfeld von Hallstatt" (Dresden, 1885), illustrated with a photographic view of the place and photographic plates of two of the finest objects found there. Although Hallstatt has been "exploited" by treasure-seekers ever since 1835, during which nearly 2000 graves have been opened, Dr. Meyer's hasty survey satisfied him that the place is still far from exhausted. Most of the graves have been rifled; but the site occupied by the neighbouring prehistoric settlement appears to have been scarcely touched, and there remain several thousand square yards of ground still to explore. Until this is done it will be difficult to come to any definite conclusion as to the origin, period, and duration of the settlement. The fact that no Keltic coins have ever been discovered at Hallstatt seems to support Morlot's view that the foundation dates from about the fourth century before the new era. Basing his calculations on the number of graves in the place, Dr. Meyer thinks that it cannot have flourished for more than two hundred years, if so long. The two objects here figured and now preserved in the Museum of Linz, are a large fibula or brooch with twelve long chain pendants spreading out like a fan, and a knife with peculiar bronze handle and iron blade.

SOME little time since an account was given in NATURE (vol. xxx. p. 271) of the edible birds'-nest caves at Gomanton, in British North Borneo. A recent number of *Die Natur* contains a translation from the Danish *Geographical Journal* of an account of a visit to certain caves in islands off the coast of the Malay Peninsula, where these nests are also produced. The islands are very small, and almost inaccessible; they lie between 8° and 10° N. latitude, and lie between twenty and forty miles off the coast. They belong to the Siamese Government, and are farmed out to contractors, who collect the nests, and despatch them to China. The harvest is during the months of March and April. As soon as the nests are built, and before the swallows begin to lay their eggs, they are collected; the birds then build second nests, and these are likewise taken away; the third nests are left undisturbed for the birds to lay and hatch. The island visited by the Danish writer was about 500 feet high, and 3000 feet in diameter. The caves are only accessible by means of rattan ladders, and the nests are collected from the roofs by means of rattan galleries and stagings. To show the impossibility of ingress and egress without artificial assistance, it is stated that about forty years ago, before the collection and sale of the nests was made a Government monopoly, about fifty Malays arrived at the caves before the Siamese, and commenced taking the nests; while they were engaged in this the Siamese arrived, and in revenge ran away with the rattan ladders, leaving the whole of the Malays to die of hunger and thirst in the caves, from which their only means of escape had been taken. Their skeletons are still in the caves. These Siamese caves appear smaller, not so well ordered, and infinitely wilder and more dangerous than those at Gomanton, but otherwise there appears little difference in the nests themselves, or in the mode of collecting them.

THE latest numbers of the Ceylon *Orientalist* (Nos. 3 and 4, vol. ii.) are largely occupied with folk-lore. The editor writes on comparative folk-lore, showing how certain Singalese stories occur elsewhere in Sanskrit and Siamese collections. Mr. Lewis's "Notes on some Oriental Folk-lore Stories" is on much the same lines, the field examined being somewhat more extensive. Thus a story from a Singalese collection of stories, the "Jataka," is found in English in Chaucer's "Pardoner's Tale." There are two other papers of a like character. The Rev. H. Horsley writes on Tamil proverbs, while Mr. Lewis concludes some interesting papers on a subject which appears to have escaped investigation hitherto—viz. the terms of relationship in Singalese and Tamil.

PROF. LODGE wishes to state that in his letter under the heading of "Permanent Magnetic Polarity," in our last issue, in the last paragraph the word "*explained*" should be "*unexplained*."

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Mr. Alfred Best; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Dr. E. Woakes; a Mountain Ka-Ka (*Nestor notabilis*) from New Zealand, presented by Mr. James Ellis; four Leopard Tortoises (*Testudo pardalis*), eleven Angulated Tortoises (*Chersina angulata*), an Areolated Tortoise (*Homopus areolata*), three Geometric Tortoises (*Testudo geometrica*), a Robben Island Snake (*Coronella phocarum*), two Infernal Snakes (*Boodon infernalis*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Common Boas (*Boa constrictor*) from South America, a West African Python (*Python sebæ*) from West Africa, presented by Mr. Daniel Nicols; two Golden Plovers (*Charadrius pluvialis*), European, a Sharp-nosed Crocodile (*Crocodilus acutus*) from Central America, deposited; three Wheatears (*Saxicola œnanthe*), British, purchased; a White-fronted Lemur (*Lemur albifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR β DELPHINI.—In 1873 Burnham discovered that the primary star of the well-known wide double-star β Delphini was itself a very close double, and a few years' observations sufficed to show that it was a binary star in rapid motion. As the companion star has now described over 180° of its apparent path, a fairly accurate approximation to the elements of its orbit is possible. An attempt has accordingly been made, first by Dubiago and more recently by Gore, to determine the orbit, with tolerably accordant results. The former makes the period to be 26·07 years, with perihelion passage at 1882·19 and semi-axis major 0″·55. Gore finds the period to be 30·91 years, and fixes the periastron passage at 1882·25, with semi-axis major = 0″·517. The observations are fairly well represented by these elements, considering what a close and difficult object the star is to measure. According to Gore's elements the components were at their minimum distance, 0″·192, at the epoch 1879·91; and during 1879 Burnham failed to elongate the star with the 18½-inch Dearborn refractor. We hope that those double-star observers who possess sufficiently powerful telescopes will not lose sight of this interesting object.

THE VELOCITY OF LIGHT AND THE SOLAR PARALLAX.—From two determinations of the velocity of light made by Prof. Michelson (in 1879 and in 1882), and from one made by himself in 1882, Prof. Newcomb concludes that the most probable value of this physical constant, expressed in kilometres per second, is 299860 ± 30. Adopting Nyrén's value of the constant of aberration from Pulkowa observations, viz. 20″·492, the corresponding value of the solar parallax is 8″·794, taking the earth's equatorial radius to be 6378·2 kilometres, as determined by Clark. We may also draw attention to the circumstance that Prof. Newcomb considers that his observations negative the hypothesis put forward by Messrs. Forbes and Young as to the existence of a difference between the velocities of rays of different colours. Had there been such a difference to anything like the extent asserted by these physicists, it would have shown a well-marked effect in Prof. Newcomb's apparatus. No trace, however, of any such effect could be seen. Prof. Michelson has arrived at similar conclusions as to the erroneous nature of the views expressed by the Scotch experimenters.

FABRY'S COMET.—The following ephemeris by Dr. H. Oppenheim (*Astr. Nach.* No. 2712) is in continuation of that given in NATURE for 1886 March 18:—

For Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
April 16	23 58 48	38 46·9 N.	9·8317	9·6825	118
18	0 13 47	37 53·4	9·8417	9·6282	145
20	0 33 27	36 24·0	9·8527	9·5686	181
22	0 58 58	33 58·3	9·8645	9·5043	230
24	1 31 39	30 2·6	9·8770	9·4370	297
26	2 12 8	23 52·1	9·8899	9·3726	376
28	2 59 25	14 52·2	9·9031	9·3229	445
30	3 50 0	3 37·0 N.	9·9165	9·3042	456

The brightness on December 2 is taken as unity.

BARNARD'S COMET.—The following ephemeris by Dr. H. Oppenheim (*Astr. Nach.* No. 2714) is from elements by Dr. A. Krueger:—

For Berlin Midnight

1886	R.A. h m. s.	Decl. ° ′	Log r	Log Δ	Brightness
March 31	1 50 22	30 45·4 N.	9·9509	0·2006	11
April 4	1 49 33	32 15·9		0·1868	
8	1 48 25	33 49·1	9·8776	0·1699	18
12	1 46 58	35 23·8		0·1494	
16	1 45 6	36 57·3	9·7962	0·1245	32
20	1 42 50	38 25·0		0·0941	
24	1 40 23	39 38·9	9·7188	0·0568	62
28	1 38 22	40 26·0		0·0111	
May 2	1 38 8	40 28·4 N.	9·6796	9·9556	118

The brightness on December 5 is taken as unity.

THE NEBULA ROUND MAIA.—MM. Perrotin and Thollon (*Comptes rendus*, cii., No. 10) have succeeded in seeing the Maia nebula "without too much difficulty"; but M. Perrotin adds, "We have seen the nebula because we knew it existed. We should certainly not have observed it else." The nebula seemed comprised in an angle of about 120°, with the opening turned towards the north-west, and the summit to Maia; one of the sides lies along the line joining Maia to Bessel's star An. 4. The general appearance is that of a faintly luminous cloud, of which the different parts are very unequally bright. A nebulous filament stretching from Maia nearly to the little star just named, and a region towards the north-east and nearly 2′ from Maia, are the brightest parts of the nebula. On one occasion exceedingly faint luminous points were suspected in the centre of this latter district.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *APRIL* 4-10

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 4

Sun rises, 5h. 30m.; souths, 12h. 3m. 0·0s.; sets, 18h. 36m.; decl. on meridian, 5° 46′ N.: Sidereal Time at Sunset, 7h. 28m.

Moon (New) rises, 5h. 43m.; souths, 12h. 2m.; sets, 18h. 32m.; decl. on meridian, 3° 6′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 23	12 27	19 31	11 37 N.
Venus	3 59	9 20	14 41	8 20 S.
Mars	14 40	21 46	4 52*	11 56 N.
Jupiter	16 54	23 7	5 20*	1 44 N.
Saturn	9 7	17 19	1 31*	22 50 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

April	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
8	Aldebaran	1	17 8	17 54	175 257
9	130 Tauri	6	23 49	0 21†	175 251
10	26 Geminorum	5½	22 25	23 18	143 285

† Occurs on the following morning.

Saturn, April 4.—Outer major axis of outer ring = 40″·9 outer minor axis of outer ring = 18″·3; southern surface visible.

April	h.	
9	4	Mercury in inferior conjunction with the Sun.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
Algol	3 0·8	40 31 N.	Apr. 10,	2 49	*m*
T Canis Minoris	7 27·7	11 59 N.	,, 9,		*M*
S Cancri	8 37·4	19 27 N.	,, 5,	0 25	*m*
T Virginis	12 8·8	5 24 S.	,, 4,		*M*
R Virginis	12 32·7	7 37 N.	,, 10,		*M*
W Virginis	13 20·2	2 47 S.	,, 9,	19 10	*m*
δ Libræ	14 54·9	8 4 S.	,, 4,	4 44	*m*
			,, 8,	20 26	*m*
U Coronæ	15 13·6	32 4 N.	,, 5,	21 54	*m*
S Coronæ	15 16·8	31 47 N.	,, 10,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 4,	2 19	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Apr. 7,	2 30	*m*
			,, 10,	0 0	*M*
U Sagittarii	18 25·2	19 12 S.	,, 5,	21 40	*m*
			,, 8,	21 30	*M*
β Lyræ	18 45·9	33 14 N.	,, 4,	2 20	*M*
S Vulpeculæ	19 43·7	27 0 N.	,, 8,		*M*
η Aquilæ	19 46·7	0 7 N.	,, 5,	21 30	*m*
δ Cephei	22 24·9	57 50 N.	,, 4,	4 50	*M*
			,, 7,	21 40	*m*

M signifies maximum; *m* minimum.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
D.M. – 0° No. 2668	13 6 55	1 9·2 S.	III.
D.M. + 47° No. 2053	13 18 13	47 35·8 N.	III.
R Hydræ	13 23 29	22 41·4 S.	III.
83 Ursæ Majoris	13 36 25	55 15·5 N.	III.
i Draconis	13 48 6	65 17·2 N.	III.
D.M. + 38° No. 2501	13 55 31	38 25·5 N.	III.
D.M. + 44° No. 2325	14 3 22	44 23·8 N.	III.
169 Schjellerup	14 19 4	26 13·4 N.	III.
V Bootis	14 25 10	39 22·1 N.	III.
R Bootis	14 32 10	27 13·9 N.	III.
LL. 26918	14 40 23	15 36·6 N.	III.
342 Birmingham	14 55 46	66 23·2 N.	III.

BIOLOGICAL NOTES

Crayfish.—The Museum of Comparative Anatomy at Harvard having an uncommonly rich collection of the genera and species of the family Astacidæ, Mr. Faxon presents us with a revision of the group, which falls little short of being a well-illustrated monograph. In the first part, which has just reached us, we find the crayfishes of the northern hemisphere treated of, and in a second part the author promises to write of those of the southern hemisphere. As will be known to all readers of Huxley's work, "The Crayfish," the family Astacidæ (which in a strict sense is equivalent to the genus Astacus, as limited by Milne-Edwards) falls naturally into two subordinate groups. These groups of Huxley's Faxon makes into sub-families: (1) the Potamobiinæ, comprising the crayfishes of Europe, Asia, and North America; and (2) the Parastacinæ, comprising those of the southern hemisphere, viz. those of South America, Fiji Islands, New Zealand, Tasmania, Australia, and Madagascar. The Potamobiinæ are treated of in this memoir, and include the genera Astacus and Cambarus. The Parastacinæ will be treated of in a second memoir. Of the genus Cambarus, established by Erichson in 1846, fifty-two species are accepted by Faxon, and all of these except one are American forms, ranging from Lake Winnipeg to Cuba and Guatemala, from New Brunswick to Wyoming Territory (in Mexico to the Pacific Ocean). The genus Cambarus would] not seem to have been developed under the influences affecting cavern life, though several cave and blind species are known, and in Europe it would appear that one solitary species still lingers in the underground waters of some of the Carniola caves. It seems strange that on so interesting a question any doubt should remain, and yet it is true that, except a short notice in the Berlin *Entomologische Zeitschrift*, by Dr. G. Joseph, of a specimen of a crayfish referred to Cambarus, and labelled, as found, "Aus der Grotte von St. Kanzian bei Metaun," we know nothing of this interesting form, which must, if the determination is correct, be taken as an indication that at one time species of Cambarus inhabited the European rivers. Of the genus Astacus fourteen species are given. These occupy three widely-separated geographical areas: (1) Western North America, from the Rocky Mountains to the Pacific Ocean; (2) the western portion of the Europeo-Asiatic continent from the Ural Mountains and the basin of the Sea of Aral to the Spanish peninsula and (?) Ireland; (3) Eastern Asia, in the Amoor River system, and in Japan. No Astaci are known from any part of Siberia between Lake Baikal and the Urals, or from any of the Siberian rivers flowing into the Arctic Ocean. To this memoir an interesting note on the fossil forms referred to Astacidæ and a table showing the geographical distribution, as far as has been ascertained, of the species of Cambarus and Astacus are appended.—["A Revision of the Astacidæ," by Walter Faxon. Part I. "The Genera Cambarus and Astacus" (with ten plates). Cambridge, for the Harvard Museum, August, 1885 (being vol. x. No. 4, of the *Memoirs* of the Museum of Comparative Anatomy).]

Habits of the Cuckoo.—However well known may be this summer visitant of ours, there are still few points in its strange life-history that have been well worked out. Even an ornithologist will hesitate to say whether it is the male or female bird which utters the familiar cry, or will be able to say when the young bird moults. In Mr. Henry Seebohm's important and just-published "History of British Birds" we find that the strongest doubts are thrown on the statements that the young cuckoo, soon after it is hatched, ejects the young or eggs of its foster-parents from the nests. "One feels inclined," we read, "to class these narratives with the *equally well authenticated* stories of ghosts and apparitions," and this, too, though these narratives are from the pens of such accurate observers as Montagu, Jenner, and others. It is therefore not without interest that we find, from a series of observations made with every precaution as to their accuracy by Mr. John Hancock (*Nat. Hist. Trans.*, Northumberland, Durham, and Newcastle-on-Tyne, vol. viii., 1886), that the observations of the older writers were exact. The nest of a hedge-accentor, built in a convenient spot for observation, was found, on January 17, 1884, to contain four eggs of the accentor and one cuckoo's egg. On the 27th the cuckoo's egg and two eggs of the accentor were hatched. On the 28th the "murder" began with an attempt on the part of the cuckoo to put out of the nest one of the unhatched eggs. At 10.30 a.m. on the same day the egg was successfully thrown out. Getting more perfect with practice, about half an hour later one of the young accentors was ejected: strange to say, its mother was present, and looked on quite calmly, but the desperate efforts of the young murderer seemed for the time to exhaust it, so that it was not until 1 p.m. that it returned to the work and pushed out the second egg, and then tried to put out the remaining accentor. This at 3.30 was done, and the cuckoo remained sole occupant. No wonder Mr. Hancock writes:—"The cuckoo's proceeding, as I saw it, is, in my opinion, the most wonderful and unaccountable piece of business that I ever witnessed in bird life." Some of our readers may like to learn that one of the unfortunate young accentors was placed in a whitethroat's nest, where there were four young ones about its own age, and that it was properly attended to by its foster-parents, whereas the young cuckoo was, after a week's short existence, found dead, apparently of sunstroke, at the bottom of its nest.

The Torture of the Fish-Hawk.—While the facts above recorded about the cuckoo are wonderful, and, from a human standpoint, perhaps cruel, they would seem to be surpassed in both respects by those recently recorded about the fish-hawk of Southern Florida by a well-known observer, J. Lancaster (*American Naturalist*, March 1886). The distribution of land and water on the Gulf coast of Florida is very favourable to the existence of fish, and the flats and creeks swarm with life. Birds subsisting on fish diet also abound. Long lines of pelicans can be seen on every hand; armies of cranes stalk about; fish-hawks abound. These latter are arboreal in their habits, nesting in the tops of the pine-trees, and rarely resting on the ground. For the most part they fish in the secluded creeks and inlets, hovering over the water and capturing their prey by suddenly diving upon it; but sometimes they fish in the open waters. While large, active-winged birds, they never soar. On first acquaintance their actions seemed inexplicable: while in the hidden creeks they uttered no cry and seemed to be masters of the gentle art; but in the open, allured thereto by a school of mullet, at the moment when they would seem eager for action and all alive with expectation, just as they might be swooping on a fish, they would emit a discordant, frightened scream, and make for the shore with a haste so ill-advised as to seriously impede their progress. The shelter of the trees gained, the terror would subside. Desire for food would tempt the bird once more out, and again and again the same frantic performance was to be witnessed. The reason was soon made evident. A fine specimen of the fish-hawk swooped on a fish, which soon left its element and swung aloft in the bird's talons. The hawk began its homeward journey. But now a new-comer appeared on the scene. A black creature, which seemed all wings, dropped from above and confronted the hawk, which at once let go its prey and uttered a scream so brimful of mortal terror as to excite one's pity. The hawk was not struck, and it made off with wild haste for shore. The intruder was a frigate-bird, which seized the dropped fish in its beak long ere the prey reached the water, and then with a sweep of exquisite grace, on tense wings, fronting a mild breeze, the corsair was lifted half a mile into the air. A bite was taken from the fish by a wringing motion of the bird's head, which sent the carcass whirling. The morsel being swallowed, the bird, folding its wings tightly on its body, dropped swiftly after the fish, seized it, again swept upwards, and then the performance was repeated till the meal was over. In a personal contest for superiority on the ground of physical strength the frigate-bird, with its small legs and feet and its head and beak not stronger than the fish-hawk's, was no match for the latter; but sometimes the fish-hawk does not play its part as capturer of the prey desired by the frigate-bird, and several of these latter combine to cut off its retreat landwards, swoop about it until the unfortunate victim loses its power of screaming, then of flight; down it falls at last exhausted into the waters of the Gulf; the demon birds still pursue it; with their miserable, puny feet they alight on it, and push it beneath the surface, continuing in one case to do this for over an hour, until the bird was dead. When the hawks captured fish they were not so treated—they were robbed, not killed. It would seem as if the existence of the fish-hawk as a species depended on their understanding this, and that now and then those that did not understand lost their lives in the struggle.

The Sensibility and Movements of Plants.—To the last number of the *Bulletin de l'Académie Royale de Belgique*, the late Prof. Morren contributes a valuable memoir on the sensibility and movements of plants, in which he further developes Darwin's well-known theory, and attempts to establish a complete synthesis of the animal and vegetable kingdoms. It is argued that the law of sensation producing motion dominates all the biological sciences, that plants are sensible to the influences of the environment, and not only move, but are able to co-ordinate their movements. All the phenomena of motion are referred in ultimate analysis to protoplasm, a living substance common alike to plants and animals, and whose general and essential characteristics are precisely the power of sensation and movement. It has the faculty of receiving external agencies, and of moving *proprio motu*. It stirs, therefore it lives! And this is equally true of all organisms from man to the microbe and the plant. Life might be defined as the activity of protoplasm, although this is a substance whose true nature is still unknown, of whose texture we are ignorant, and whose activity is a property, the mechanism of which has not yet been discovered.

Heredity.—The same *Bulletin* contains an equally interesting paper by M. Ch. Van Bambeke, on heredity, in which the theories of Darwin, Haeckel, Nägeli, Pflüger, and others are subjected to a searching criticism. Both pangenesis and plastidulperigenesis are rejected, as inadequate to explain all the phenomena of heredity, which, it is argued, can be accounted for only by supposing that the germ, Weismann's *Keimplasma*, is in fact continuous. It is not to be regarded as the final outcome of the ontogenesis of each individual, but passes from parent to offspring directly, being from the first present in an unmodified form in a large number, possibly in all the somatic cells. The germinative plasma persists through certain cellular series, concentrating itself anew in the embryonic cells of the new organism. In a word, in the phylogenetic development of the organisms the germ, whose true seat has now been determined, is perpetuated throughout the whole series of successive ontogenies. The generations succeed and efface each other; the *Keimplasma* alone is immortal.

GEOGRAPHICAL NOTES

The progress of drying up of the steppes around the Caspian Sea is steadily going on. Thus we learn from a recent communication by M. Krasnoff to the Geographical Society that the series of the Sarpinsk lakes in the eastern part of the Kalmuck steppes, close to the Ergheni hills, are rapidly disappearing; the lakes Chilguir and Keke-tzun have quite disappeared in the course of the last year.

General Tillo publishes in the last issue of the *Izvestia* of the Russian Geographical Society the results of new exact levellings made in order to ascertain the heights above the sea of Lakes Ladoga, Onega, and Ilmen. Their respective heights above the average level of the Gulf of Finland appear to be only 16, 115, and 59 feet, with a probable error not exceeding 1·5 feet. The formerly accepted heights were 59, 237, and 157 feet.

A very interesting paper on the irrigation of the oases of Merv and Akhal-Tekke was recently read by M. Pokrovski-Kozel at St. Petersburg, before the Society for the Assistance of Russian Trade and Commerce, Count Ignatieff being in the chair. The lecturer considers the Merv oasis as one of the most fertile spots on the earth. Wheat, rice, and other cereals cultivated by natives for home consumption yield beautiful crops. The oasis includes about 900,000 acres of cultivable land. But, in order to cultivate them, it would be necessary to colonise the oasis with civilised pioneers, and to spend about 120,000*l*. on the restoration and extension of the splendid system of canals built up by the Arabs a thousand years ago, and preserved until now in some parts, as, for instance, at the mouth of the River Murhab, about 50 miles from Merv. These canals are 14 feet deep and 70 feet wide, and partly used even now by the Merv Turcomans for the irrigation of their fields, though in a primitive manner. The Akhal-Tekke oasis is not so rich as that of Merv, but still it has about 900,000 acres of land suitable for culture. It covers the space of 7 miles along the railway line from Mikhailovsk Bay to Khizil Arvat, and could be irrigated by the water from the River Tejen.

The Imperial Russian Geographical Society has decided in its Natural Science Section, to organise during the current year another expedition to Central Asia, in order to investigate the mountain district of Khan-Tengri, which has never yet been explored by any of the European travellers in Central Asia.

PROF. GUIDO CORA has lately printed the address he delivered in November 1883 at the opening of the annual course of geographical studies in the University of Turin. This address, dealing with the surface of the earth as the proper subject of geography, has a special interest for the English public, who are just now occupied with the question of geographical reform. The author accordingly appeals more particularly to those English men of science "who seem still to entertain grave doubts whether geography really possesses a scientific and individual character, and whether it is entitled to be taught even in Universities." Amongst the subjects discussed are, the relations of geography to the other sciences, geography an individual science, separation of geology from geography, division of geography in reference to its subject-matter and methods of investigation, mathematical and physical geography, necessity of teaching geography according to the most exact scientific and didactic methods.

AT the last meeting of the Geographicnl Society of Paris, a letter was read from Major Serpa Pinto, dated Zanzibar, December 10, describing his recent explorations in Eastern Equatorial Africa. He started from Mozambique, and followed the coast, carefully examining the country as he proceeded, until he reached Ibo. Here he organised a large expedition with 200 guards and 700 bearers, carrying provisions and wares, and started for Lake Nyassa, which he reached without difficulty. On the journey he undertook a triangulation survey with levelling. Major Pinto was forced to return to the coast by himself from Nyassa, on account of ill-health; but M. Cardozo, his second in command, continued the journey, and at the time of writing should have been between Nyassa and Bangweolo. Capt. Monteil, of the French Marines, read a paper on the French establishments in Senegal.

A LENGTHY report from M. Thouar to the President of the Argentine Republic, on the Pilcomayo River, has been published. The object of his last exploration was to seek the branch of the river which was most navigable. Leaving Fort Fotheringham on October 25, he reached, on November 12, the rapids, the point which, from the other side, he reached with the Bolivian Expedition in 1883. His conclusion is that it is possible to go at any season of the year from the mouth at Lamboré to the mission of San Francisco de Solano in Bolivia, at the very foot of the Andes, at a short distance from the principal commercial centres of Southern Bolivia. The difficulties caused by accumulations of trees, and the consequent formation of shallows can, in his judgment, be overcome. The report then goes on to describe the incidents of the journey, and the hostility of the Toba Indians, which more than once threatened the existence of the Expedition. M. Thouar left in the beginning of February for Bolivia, crossing the Chaco between the 18th and 19th parallels, still intent on his exploration of the Pilcomayo from the Bolivian side.

THE current *Zeitschrift* (Bd. xxi. Heft 1) of the Berlin Geographical Society has for its first contribution a paper of great interest on the discovery and conquest of Chili, the portion published in the present number dealing with the period between the discovery of the Straits of Magellan and the death of Pedro de Valdivia (1520-54). The writer, Herr Polakowsky, tells the story of the stirring events of which Chili was the theatre at this time with much fire and vigour. The second paper is also devoted to South America. It is an account (accompanied by a map) by Capt. Rohde, of the expedition of Gen. Victorica to the Grand Chaco. The writer first gives some general information about the Chaco, its size, natural divisions, productions, flora and fauna, so far as they are known; then he refers to earlier expeditions, and this brings him to the plan of the campaign under review, and to the events attending the march of the column specially under the command of General Victorica, and of the other columns acting in conjunction with it. As part of this comes the work on the Pilcomayo and Bernejo of Lieut. Feilberg, of which much has already been heard in Europe. In conclusion a list is given of the trees of the Chaco, their native and botanical names, with a few words of description in each case. A shorter paper (the last in the number) is a report on the same expedition by the head of the Topographical Department of the Argentine army. From a geographical and geological point of view this is the most valuable part of the accounts of the campaign. It describes the geology, climate, zoology, mineralogy, &c., of the Chaco.

THE *Verhandlungen* (Band xiii., No. 2) of the same Society contains a paper, by Dr. Zintgraff, entitled "Impressions of the Lower Congo." The writer was a volunteer with Dr. Chavanne, who was despatched to map the lower part of the river, and does not appear to be able to add much that is new to our knowledge of this region. Dr. Ehrenreich writes on the land and people in the Rio Doce in Brazil. This is a paper of much interest, as it sketches the life and habits of a comparatively little-known people, from long and careful observation. Herr Paul Reichard has a long report on his journeys in Eastern Africa and the regions around the source of the Congo. These journeys, of which much has been heard from time to time, extended over about five years, and the present is a popular account of some of their leading features.

THE *Mittheilungen* of the Vienna Geographical Society (Band xxix., No. 2) contains an account by Dr. Breitenhohner, the Director of the Meteorological Station at Sonnblick, near Salzburg, which is the loftiest in the world, being more than twice as high as the Ben Nevis Station. Herr Steinhauser continues and concludes his review of the mathematical geography of the last five years, which takes the form of a series of notes on various books. Dr. Diener continues his contribution to the geography of Central Syria, while further letters from the Congo, from Dr. Lenz, are published.

UNIVERSAL OR WORLD TIME[1]

CONSIDERING the natural conservatism of mankind in the matter of time-reckoning it may seem rather a bold thing to propose such a radical change as is involved in the title of my discourse. But in the course of the hour allotted to me this evening, I hope to bring forward some arguments which may serve to show that the proposal is not by any means so revolutionary as might be imagined at the first blush.

A great change in the habits of the civilised world has taken place since the old days when the most rapid means of conveyance from place to place was the stage-coach, and minutes were of little importance. Each town or village then naturally kept its own time, which was regulated by the position of the sun in the sky. Sufficient accuracy for the ordinary purposes of village life could be obtained by means of the rather rude sun-dials which are still to be seen on country churches, and which served to keep the village clock in tolerable agreement with the sun. So long as the members of a community can be considered as stationary, the sun would naturally regulate, though in a rather imperfect way, the hours of labour and of sleep and the times for meals, which constitute the most important epochs in village life. But the sun does not really hold a very despotic sway over ordinary life, and his own movements are characterised by sundry irregularities to which a well-ordered clock refuses to conform.

Without entering into detailed explanation of the so-called "Equation of Time," it will be sufficient here to state that, through the varying velocity of the earth in her orbit, and the inclination of that orbit to the ecliptic, the time of apparent noon as indicated by the sun is at certain times of the year fast and at other times slow, as compared with 12 o'clock or noon by the clock. [The clock is supposed to be an ideally perfect clock going uniformly throughout the year, the uniformity of its rate being tested by reference to the fixed stars.] In other words, the solar day, or the interval from one noon to the next by the sun, is at certain seasons of the year shorter than the average, and at others longer, and thus it comes about that by the accumulation of this error of going, the sun is at the beginning of November more than 16 minutes fast, and by the middle of February 14½ minutes slow, having lost 31 minutes, or more than half-an-hour, in the interval. In passing it may be mentioned as a result of this that the afternoons in November are about half-an-hour shorter than the mornings, whilst in February the mornings are half-an-hour shorter than the afternoons. In view of the importance attached by some astronomers to the use of exact local time in civil life, it would be interesting to know how many villagers have remarked this circumstance.

It is essential to bear these facts in mind when we have to consider the extent to which local time regulates the affairs of life, and the degree of sensitiveness of a community to a deviation of half-an-hour or more in the standard reckoning of time. My own

[1] Lecture by W. H. M. Christie, F.R.S., Astronomer-Royal, at the Royal Institution, March 19, 1886.

experience is that in districts which are not within the influence of railways the clocks of neighbouring villages commonly differ by half-an-hour or more. The degree of exactitude in the measurement of local time in such cases may be inferred from the circumstance that a minute hand is usually considered unnecessary. I have also found that in rural districts on the Continent arbitrary alterations of half-an-hour fast or slow are accepted not only without protest but with absolute indifference.

Even in this country where more importance is attached to accurate time, I have found it a common practice in outlying parts of Wales (where Greenwich time is about 20 minutes *fast* by local time) to keep the clock half-an-hour fast by railway (*i.e.* Greenwich) time, or about 50 minutes fast by local time. And the farmers appeared to find no difficulty in adapting their hours of labour and times of meals to a clock which at certain times of the year differed more than an hour from the sun.

There is a further irregularity about the sun's movements which makes him a very unsafe guide in any but tropical countries. He is given to indulging in a much larger amount of sleep in winter than is desirable for human beings who have to work for their living and cannot hibernate as some of the lower animals do. To make up for this he rises at an inconveniently early hour in summer and does not retire to rest till very late at night. Thus it would seem that a clock of steady habits would be better suited to the genius of mankind.

Persons whose employment requires daylight must necessarily modify their hours of labour according to the season of the year, whilst those who can work by artificial light are practically independent of the vagaries of the sun. Those who work in collieries, factories, or mines, would doubtless be unconscious of a difference of half-an-hour or more between the clock and the sun, whilst agriculturists would practically be unaffected by it, as they cannot have fixed hours of labour in any case.

Having thus considered the regulating influence of the sun on ordinary life within the limits of a small community, we must now take account of the effect of business intercourse between different communities separated by distances which may range from a few miles to half the circumference of our globe. So long as the means of communication were slow, the motion of the traveller was insignificant compared with that due to the rotation of the earth, which gives us our measure of time. But it is otherwise now, as I will proceed to explain.

Owing to the rotation of the earth about its axis, the room in which we now are is moving eastward at the rate of about 600 miles an hour. If we were in an express train going eastward at a speed of sixty miles an hour (relatively to places on the earth's surface), the velocity of the traveller due to the combined motions would be 660 miles an hour, whilst if the train were going westward it would be only 540 miles. In other words, if local time be kept at the stations, the apparent time occupied in travelling sixty miles eastward would be 54 minutes, whilst in going sixty miles westward it would be 66 minutes. Thus the journey from Paris to Berlin would apparently take an hour and a half longer than the return journey, supposing the speed of the train to be the same in both cases.

In Germany, under the influence of certain astronomers, the system of local time has been developed to the extent of placing posts along the railways to mark out each minute of difference of time from Berlin. Thus there is an alteration of one minute in time reckoning for every ten miles eastward or westward, and even with the low rate of speed of German trains, this can hardly be an unimportant quantity for the engine-drivers and guards, who have to alter their watches one minute for every ten miles they have travelled east or west. This would seem to be the *reductio ad absurdum* of local time.

In this country the difficulty as to the time reckoning to be used on railways was readily overcome by the adoption of Greenwich time throughout Great Britain. The railways carried London (*i.e.* Greenwich) time all over the country, and thus local time was gradually displaced. The public soon found that it was important to have correct railway time, and that even in the west of England, where local time is about 20 minutes behind Greenwich time, the discordance between the sun and the railway clock was of no practical consequence. It is true that for some years both the local and the railway times were shown on village clocks by means of two minute-hands, but the complication of a dual system of reckoning time naturally produced inconvenience, and local time was gradually dropped. Similarly in France, Austria, Hungary, Italy, Sweden, &c., uniform time has been carried by the railways throughout each country. It is noteworthy that in Sweden the time of the meridian one hour east of Greenwich has been adopted as the standard, and that local time at the extreme east of Sweden differs from the standard by about 36½ minutes.

But in countries of great extent in longitude such as the United States and Russia, the time-question was not so easily settled. It was in the United States and Canada that the complication of the numerous time standards then in use on the various railways forced attention to the matter. To Mr. Sandford Fleming, the constructor of the Inter-Colonial Railway of Canada and engineer-in-chief of the Pacific Railway, belongs the credit of having originated the idea of a universal time to be used all over the world. In 1879 Mr. Fleming set forth his views on time-reckoning in a remarkable paper read before the Canadian Institute. In this he proposed the adoption of a universal day, commencing at Greenwich mean noon or at midnight of a place on the anti-meridian of Greenwich, *i.e.*, in longitude 180° from Greenwich. The universal day thus proposed would coincide with the Greenwich astronomical day, instead of with the Greenwich civil day which is adopted for general use in this country.

The American Metrological Society in the following year issued a report recommending that, as a provisional measure, the railways in the United States and Canada should use only five standard times, 4, 5, 6, 7, and 8 hours respectively later than Greenwich, a suggestion originally made in 1875 by Prof. Benjamin Peirce. This was proposed as an improvement on the then existing state of affairs, when no fewer than seventy-five different local times were in use on the railroads, many of them not differing more than 1 or 2 minutes. But the committee regarded this merely as a step towards unification, and they urged that eventually one common standard should be used as railroad and telegraph time throughout the North American continent, this national standard being the time of the meridian 6 hours west of Greenwich, so that North American time would be exactly 6 hours later than Greecenwich time.

Thanks to the exertions of Mr. W. F. Allen, Secretary of the General Railway Time Convention, the first great practical step towards the unification of time was taken by the managers of the American railways on November 18, 1883, when the five time standards above mentioned were adopted. Mr. Allen stated in October 1884 that these times were already used on 97½ per cent. of all the miles of railway lines, and that nearly 85 per cent. of the total number of towns in the United States of over 10,000 inhabitants had adopted them.

I wish to call particular attention to the breadth of view thus evidenced by the managers of the American railways. By adopting a national meridian as the basis of their time-system, they might have rendered impracticable the idea of a universal time to be used by Europe as well as America. But they rose above national jealousies, and decided to have their time-reckoning based on the meridian which was likely to suit the convenience of the greatest number, thus doing their utmost to promote uniformity of time throughout the world by setting an example of the sacrifice of human susceptibilities to general expediency.

Meanwhile Mr. Sandford Fleming's proposal had been discussed at the Geographical Congress at Venice in 1881, and at a meeting of the Geodetic Association at Rome in 1883. Following on this a special Conference was held at Washington in October 1884, to fix on a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the globe. As the result of the deliberations it was decided to recommend the adoption of the meridian of Greenwich as the zero for longitude, and the Greenwich civil day (commencing at Greenwich midnight and reckoned from 0 to 24 hours) as the standard for time reckoning. In making this selection the delegates were influenced by the consideration that the meridian of Greenwich was already used by an overwhelming majority of sailors of all nations, being adopted for purposes of navigation by the United States, Germany, Austria, Italy, &c. Further, the United States had recently adopted Greenwich as the basis of their time-reckoning, and this circumstance in itself indicated that this was the only meridian on which the Eastern and Western Hemispheres were likely to agree.

The difficulties in the way of an agreement between the two hemispheres may be appreciated by the remarks of the Superintendent of the American Ephemeris on Mr. Sandford Fleming's scheme for universal time (which was subsequently adopted in its essentials at the Washington Conference):—"A capital plan for use during the millenium. Too perfect for the present state of humanity. See no more reason for considering Europe in the matter than for considering the inhabitants of the planet Mars. No; we don't care for other nations, can't help them, and they can't help us." [1]

As a means of introducing universal time, it has been proposed by Mr. Sandford Fleming, Mr. W. F. Allen, and others, that standard times based on meridians differing by an exact number of hours from Greenwich should be used all over the world. In some cases it may be that a meridian differing by an exact number of half-hours from Greenwich would be more suitable for a country like Ireland, Switzerland, Greece, or New Zealand, through the middle of which such a meridian would pass, whilst one of the hourly meridians would lie altogether outside of it.

The scheme of hourly meridians, though valuable as a step towards uniform time, can only be considered a provisional arrangement, and though it may work well in countries like England, France, Italy, Austria, Hungary, Sweden, &c., which do not extend over more than one hour of longitude, in the case of such an extensive territory as the United States difficulties arise in the transition from one hour-section to the next which are only less annoying than those formerly experienced, because the number of transitions has been reduced from seventy-five to five, and the change of time has been made so large that there is less risk of its being overlooked. The natural inference from this is that one time-reckoning should be used throughout the whole country, and thus we are led to look forward to the adoption in the near future of a national standard time, 6 hours slow by Greenwich, for railways and telegraphs throughout North America.

We may then naturally expect that by the same process which we have witnessed in England, France, Italy, Sweden, and other countries, railway time will eventually regulate all the affairs of ordinary life. There may of course be legal difficulties arising from the change of time-reckoning, and probably in the first instance local time would be held to be the legal time unless otherwise specified.

It seems certain that when a single standard of time has been adopted by the railways throughout such a large tract of country as North America, where we have a difference of local times exceeding five hours, the transition to universal time will be but a small step.

But it is when we come to consider the influence of telegraphs on business life, an influence which is constantly exercised, and which is year by year increasing, that the necessity for a universal or world time becomes even more apparent. As far as railways are concerned, each country has its own system, which is to a certain extent complete in itself, though even in the case of railways the rapidly increasing inter-communication between different countries makes the transition in time-reckoning on crossing the frontier more and more inconvenient. Telegraphs, however, take no account of the time kept in the countries through which they pass, and the question, as far as they are concerned, resolves itself into the selection of that system of time-reckoning which will give least trouble to those who use them.

For the time which is thus proposed for eventual adoption throughout the world, various names have been suggested. But whether we call it Universal, Cosmic, Terrestrial, or what seems to me best of all, World Time, I think we may look forward to its adoption for many purposes of life in the near future.

The question, however, arises as to the starting-point for the universal or world day. Assuming that, as decided by the great majority of the delegates at Washington, it is to be based on the meridian of Greenwich, it has still to be settled whether the world day is to begin at midnight or noon of that meridian. The astronomers at Rome decided by a majority of twenty-two to eight in favour of the day commencing at Greenwich noon, that is, of making the day throughout Europe begin about mid-day. However natural it might be for a body of astronomers to propose that their own peculiar and rather inconvenient time-reckoning should be imposed on the general public, it seems safe to predict that a World Day which *commenced* in the middle of their busiest hours would not be accepted by business men. In fact, the idea on which this proposal was founded was that universal time would be used solely for the internal administration of railways and telegraphs, and that accurate local time must be rigidly adhered to for all other purposes. It was conceded, however, that persons who travelled frequently might with advantage use universal time during railway journeys. This attempt to separate the travelling from the stationary public seems to be one that is not likely to meet with success even temporarily, and it is clear that in the future the latter class may be expected to be completely absorbed in the former. Another argument that influenced the meeting at Rome was the supposed use of the astronomical day by sailors. Now it appears that sailors never did use the astronomical day, which begins at the noon *following* the civil midnight of that date, but the nautical day, which begins at the noon *preceding*, *i.e.* twenty-four hours before the astronomical day of the same date, ending when the latter begins. And the nautical day itself has long been given up by English and American sailors, who now use a sort of mongrel time-reckoning, employing civil time in the log-book and for ordinary purposes, whilst, in working up the observations on which the safe navigation of the ship depends, they are obliged to change civil into astronomical reckoning, altering the date where necessary, and interpreting their a.m. and p.m. by the light of nature. It says something for the common-sense of our sailors that they are able to carry out every day without mistake this operation, which is considered so troublesome by some astronomers.

In this connection I may mention that the Board of Visitors of Greenwich Observatory have almost unanimously recommended that, in accordance with the resolution of the Washington Conference, the day in the English Nautical Almanac should be arranged from the year 1891 (the earliest practicable date) to begin at Greenwich midnight (so as to agree with civil reckoning, and remove this source of confusion for sailors), and that a committee appointed by them have drawn up the details of the changes necessary to give effect to this resolution without causing inconvenience to the mercantile marine.

The advantage of making the world day coincide with the Greenwich civil day is that the change of date at the commencement of a new day falls in the hours of the night throughout Europe, Africa, and Asia, and that it does not occur in the ordinary office hours (10 a.m. to 4 p.m.) in any important country except New Zealand. In the United States and Canada the change of date would occur after four in the evening, and in Australia before ten in the morning. This arrangement would thus reduce the inconvenience to a minimum, as the part of the world in which the change of date would occur about the middle of the local day is almost entirely water, whilst on the opposite side we have the most populous continents.

The question for the future seems to be whether it will be found more troublesome to change the hours for labour, sleep, and meals once for all in any particular place, or to be continually changing them in communications from place to place, whether by railway, telegraph, or telephone. When universal or world time is used for railways and telegraphs, it seems not unlikely that the public may find it more convenient to adopt it for all purposes. A business man who daily travels by rail, and constantly receives telegrams from all parts of the world, dated in universal time, would probably find it easier to learn once for all that local noon is represented by 17h. U.T. and midnight by 5h. (as would be the case in the Eastern States of North America), and that his office hours are 15h. to 21h. U.T., than to be continually translating the universal time used for his telegrams into local time.

If this change were to come about, the terms noon and midnight would still preserve their present meaning with reference to local time, and the position of the sun in the sky, but they would cease to be inseparably associated with 12 o'clock.

[1] *Proceedings* of the Canadian Institute, Toronto, No. 143, July 1885.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 2, 1886.—On the galvanic conductivity of some easily fusible metallic alloys, by C. L. Weber.—On the electric conductivity of double-salts, by E. Klein.—On the galvanic polarisation of lead, by F. Streintz and E. Aulinger.—Experiment to determine the maximum of galvanic polarisation, by A. Föppl.—On the electro-magnetic rotation of the polarisation of light in iron, by A. Kundt.—Electro-magnetic rotation of natural light, by L. Sohncke.—On determination of the capillary constants of liquids, by S. Quincke.—On the relative permeability of different diaphragms and their availability as dialytic partitions, by A. Zott.—On the influence of temperature and concentration on the fluidity of liquid mixtures, by K. Novak.—On the dispersion-equivalent and coefficient of expansion of sulphur, by A. Schrauf.

Bulletin de l'Académie Royale de Belgique, December 1885.—Some remarks on Gen. Liagre's remarks and Baeyer's posthumous note on winter and summer tides, by M. Folie. The statements that the tides are higher in summer owing to the greater heat of the sun, and that for the same reason there is greater barometric pressure, are both shown to be groundless.—Note on the Middle Devonian rocks of Belgium: the Givet limestones, their stratigraphic relations and distribution, by E. Dupont. The pure limestones of the Givet epoch are classified as under: (1) Fossiliferous gray, with stromatopores, favosites, alveolites, &c.; (2) deep blue, rarely lilac, granular or sub-compact, occasionally schistoid; (3) blue sub-compact, with small spathose particles disseminated; (4) oolithic gray; (5) fissured gray. All these limestones are distinctly stratified.—The Cetaceans of the European waters, by P. J. Van Beneden. These Cetaceans, which are described in detail, are divided into three groups: (1) Balænidæ, or true whales, such as *B. biscayensis*, *Balænoptera sibbaldii*, &c.; (2) Ziphioidæ, or Cetodonts with teeth in the lower jaw only, such as the Cachalot (*Pyseter macrocephalus*), *Hyperoodon rostratus*, &c.; (3) Delphinidæ, or Cetodonts with two rows of teeth piercing the gums, such as *Phocæna communis*, *Globiceps melas* (the Grindewall of the Orkneys), *Orca gladiator*, *Grampus griseus*, &c.—The Camiguin volcano, by A. Renard. A full description is given of the geological constitution and other natural features of this volcanic island, one of the most remarkable in the Philippine Archipelago.—Note on the meteoric display of November 27, and on an enigmatical luminous phenomenon observed on November 28, 1885, by F. Terby. In a field of observation about one-fifth of the celestial horizon the author observed, at Brussels, 1806 meteors in 57 minutes, or a mean of 31·7 per minute, which for the whole sky would give a mean of 158·4 per minute. The moment of maximum intensity appeared to be 6.16 p.m., when the meteors passed at the rate of forty-nine per minute. At 7.50 the following evening, during a violent storm accompanied by heavy rain, the observer noticed, at about 60° above the southern horizon, a very luminous region of spherical form, with a diameter of from 5° to 8°. The phenomenon, which returned at 8.5, lay evidently behind the clouds, by which it was more or less obscured. Its altitude and position seemed to connect it with the needle of magnetic inclination, and it may have been associated with an aurora borealis partly concealed by the clouds.—On a new method of separating and effecting a quantitative analysis of cadmium and copper, by Dr. Leo Backenlandt.—On the Bacteria of bread fermentation, by Emile Laurent. It is shown that viscous bread is produced by *Bacillus panificans*, which renders the albuminoids soluble, feeding on saccharose, and at a depth of 7 or 8 mm. resisting the baking process. It abounds in ordinary bread, and, after the baking, may attack the starch when not sufficiently acid, transforming it to a substance analogous to erythrodextrine. The formation of viscous bread may be prevented by the addition of a sufficient quantity of organic acid.

Rivista Scientifico-Industriale, January 31.—Notes on the three comets recently discovered by Fabry, Barnard, and Brooks, by Prof. Tempel. The last-mentioned already passed its perihelion in November, but the two others will both be visible simultaneously and not far apart from each other during the second half of April and the first of May next. It is possible that Fabry's may even be projected on the solar disk on April 26 and 27.—Description of a new polarimeter (three illustrations), by Prof. Augusto Righi. The apparatus here described belongs to the penumbra type of polarimeters, which are now universally preferred, especially for measuring the rotation of vibrations. The inventor believes it to be as sensitive as those of Jellet or Laurent, while combining in itself the special advantages which are separately possessed by those two instruments.—New facts on etherification by double decomposition, by Dr. Giacomo Bertoni. Berthelot having stated that the analogies between the ethers and the salts are superficial and that profound differences exist between them, supporting this view by the assertion that direct metathesis at a cold temperature has not been obtained on organic compounds, the Italian chemist, on the contrary, here demonstrates that metathesis between organic bodies really takes place in the same way. Thus is demonstrated the extension of Berthelot's own law to organic compounds, and the principle being in perfect harmony with thermo-dynamics, in no way contradicts the laws of thermo-chemistry. With these brilliant researches Dr. Bertoni not only illustrates the theoretical aspect of modern chemistry, but also opens a wide field for new and useful applications.

Rendiconti del Reale Istituto Lombardo, February 4.—On the birational transformations of three geometrical forms of the second species, by Prof. G. Jung. The subject is treated under three separate heads. In the first are generalised some properties of the geometrical forms of the second species; in the second is given a new demonstration of two familiar formulas which occur in the theory of birational transformations; in the third the aforesaid properties are discussed in connection with some analogous subjects recently treated by several writers, especially with the question of undetermined analysis solved by De Jonquières (*Comptes rendus*, November 2 and 9, 1885) and the researches of Autonne on the groups of birational substitutions.—On the reciprocal linear correspondences in a linear space of any species, by F. Aschieri. It is shown that two fundamental forms of h species in a linear space $Sn - 1$ will be reciprocal if one is obtained from the other with a finite number of operations (projections and sections), and will constitute a polar system in respect of a general quadrature belonging to one of said forms.—A theorem on the functions each term of which is a function of $z (= x + iy)$, by Prof. Giulio Ascoli.—Meteorological observations made at the Brera Observatory, Milan, during the month of January.

Sitzungsberichte der physikalisch-medizinischen Societät zu Erlangen, Heft 17, 1885.—On alkaline fermentation of urea, and on "urea-ferment," &c., by W. Leube.—The diffraction-phenomena of a circular aperture and a circular shield, by E. Lommel.—On reducible curves, by M. Noether.—On some syntheses in the pyrrol series, by L. Know.—Projection of the interference of liquid waves, by E. Lommel.—Visible representation of the focus of the ultra-red rays by phosphorescence, by the same.—The discriminants of the binary form of the sixth degree, by R. Gordan.—On calomel, by R. Fleischer.—On partial arching of the tympanum with moderate increase of the air-pressure in the outer auditory passage, by W. Kiesselbach.—On an anomaly of the lower *vena cava*, by L. Gerlach.—On a new way of making glass windows in the shell of birds' eggs before or in the first stage of incubation, by L. Gerlach.

Revue d'Anthropologie, tome i. fasc. 1, Paris, 1886.—M. Topinard, editor of the *Revue*, treats at great length of the measurements made by Dr. P. Broca, of various crania derived from the so-called Baye Caverns in the valley of Petit-Morin (Marne). These caves, of which M. de Baye has thoroughly explored 120, have been excavated by the hand of man in the chalk, both as habitations and as places of burial, and from the appearances of the two hundred and odd skulls that have already been brought to light, and the general character of the finds, these deposits may be referred to the polished stone age. Dr. P. Broca's hitherto unpublished measurements of forty-four of these crania, and his explanations of the methods adopted in his determinations, together with his remarks on the evidence favouring his opinion that two mixed races were represented in the remains of the Marne caves, are accepted by M. Topinard as incontrovertible proof of an augmentation in the mean cephalic index among the successive races who advanced from the south to the north of France during the Neolithic period. The general mean of the index of the forty-four crania was found by Broca to be 78·1, while he gives 72·6 for the Cave-men of L'Homme Mort, and 79·5 for the men of the dolmen of Vauréal, near Paris, the Baye Cave skulls thus presenting a mean between these extremities. The present paper, which is a sequel to the series published by the Society from the mass of materials left by Broca in a more or less complete condition, will be followed by others of similar interest.—On the Cro-Magnon race, their migrations and descendants, by M. le Dr. Verneau. The author is of opinion that the Cro-Magnon type was not effaced in the Glacial period, and that it still survives in many parts of France and Italy, and nowhere in greater purity than among the Western Basques, while recent researches in Spain and Portugal show that a race presenting identical cranial characteristics had spread from one extremity of the peninsula to the other. M. Verneau believes that their presence may be traced from the valley of the Vézère, with its Cave-men, to the dolmen regions of North-West Africa, and even to the Canary Isles, and that the race, which was one of hunters, migrated from north to south in pursuit of the game on which its existence depended.—The Kirghis, by M. Nicolas Seeland.

The author, from his position as Medical Director for the province of Sémiretchie, where the Kirghis population numbers more than 550,000, has had exceptional opportunities for observing the social and domestic habits of the people; and his carefully-conducted craniometric and other measurements, together with his exhaustive remarks on the physical, moral, and intellectual characteristics of the people, their language and literature, religion and superstitions, and the past and probable future effects on the race of closer contact with Western civilisation, supply valuable materials towards the history of these ancient tribes, whose numbers are computed at upwards of a million and a half.—On the so-called cup-like excavations, "Pierres à Cupules," by M. de Nadaillac. The author passes in review the most remarkable of these stone-markings, which have been found in the most widely-separated parts of the globe since they first attracted notice in Switzerland in 1849. In Brittany, where such stone-markings and depressions have of late years been found in great numbers, they appear to be contemporaneous with the dolmen age. M. de Nadaillac is of opinion that the general similarity of the markings, of which he gives various clear drawings, cannot be accepted as a proof of any ethnic connection between the various peoples who designed them, and is probably only to be referred to a general similarity of intelligence among men at one and the same stage of their respective courses of development.—Contributions to the history of muscular anomalies, by M. Ledouble. In the present paper, which is a sequel to the author's articles in last year's *Revue* on the major and minor pectorals, he treats specially of the variations of length and breadth in the abdominal muscles, considering each anomaly from a comparative anatomical point of view.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 28.—"On the Development of the Cranial Nerves of the Newt." By Alice Johnson, Demonstrator of Biology, Newnham College, Cambridge, and Lilian Sheldon, Bathurst Student, Newnham College, Cambridge. Communicated by Prof. M. Foster, Sec. R.S.

February 25.—"On Radiant Matter Spectroscopy: Note on the Earth Yα." By William Crookes, F.R.S.

Among the samarskite earths which concentrate towards the middle of the fractionations there is one (or a group) which presents in the radiant matter tube a well-marked phosphorescent spectrum differing from those I have already described.

The measurements of the bands and lines are given below:—

Scale of spectroscope	λ	$\frac{1}{\lambda^2}$	Remarks
10·325	6446	2407	Approximate centre of a red band shaded off on the least refrangible side.
10·310	6415	2430	Somewhat sharp edge of the red band.
10·185	6189	2611	Approximate centre of a very faint orange band.
10·130	6094	2693	A sharp narrow orange-red line.
10·05	5970	2806	Approximate centre of a narrow bright orange band. (Between this line and 2693 is a fainter semi-continuous orange band).
9·840	5676	3104	Approximate centre of a narrow bright green band.
9·790	5613	3174	Approximate centre of a narrow green band, not quite so bright as 3104.
9·690	5495	3312	Approximate centre of a bright green band, wider than the other three green bands.
9·610	5406	3422	Approximate centre of a narrow bright green band.

The earth giving the above spectrum, when sufficiently purified, presents all the characteristics of the earth discovered by Marignac, and provisionally called by him Yα (*Comptes rendus*, xc. p. 899). Through the kindness of M. de Marignac I have been enabled to compare a specimen of Yα of his own preparation with the earth described above. The two earths agree in their chemical characteristics, and their phosphorescent spectra are practically identical.

No name has yet been given to this earth, as the discoverer appears to be in some doubt whether it is not identical with J. Lawrence Smith's earth mosandra (*Comptes rendus*, lxxxvii. p. 145; lxxxvii. p. 831; lxxxix. p. 480). A specimen of mosandra prepared by J. Lawrence Smith, and sent me by M. de Marignac, gave a phosphorescent spectrum showing that it was compound, and that yttria was one of its constituents.

"On a Comparison between Apparent Inequalities of Short Period in Sunspot Areas and in Diurnal Declination Ranges at Toronto and at Prague." By Prof. Balfour Stewart, F.R.S., and William Lant Carpenter, B.A., B.Sc.

The authors discuss these inequalities in precisely the same manner in which they discussed those of a previous communication (*Proc.* Roy. Soc., vol. xxxvii. p. 290), and are led to the following conclusions:—

(α) When disturbances are excluded as much as possible, both the Toronto and the Prague declination inequalities exhibit signs of duplicity of phase, the predominant maximum at both observatories occurring shortly after the sunspot maximum for inequalities around twenty-four days.

(β) On the other hand, for inequalities around twenty-six days the predominant maximum for both observatories more nearly coincides in time with the subsidiary maximum of the twenty-four day inequalities.

(γ) The short-period inequalities of this paper are as nearly as possible equally developed and equally traceable for temperature and for declination ranges.

(δ) When disturbances are excluded as much as possible, corresponding phases appear to take place at Toronto three or four days before they take place at Prague.

March 4.—The Bakerian Lecture.—"Colour Photometry." By Capt. W. de W. Abney, F.R.S., and Major-Gen. Festing, R.E.

One of the authors of this paper has already communicated to the Physical Society of London (*Phil. Mag.* 1885) a method by which a patch of monochromatic light can be thrown on a screen. This formed the starting-point of the present investigation, which was to ascertain whether it was practicable to compare with each other the intensity of lights of different colours.

The authors describe various plans they adopted to effect this purpose, and finally found that, by placing a rod in front of the patch of monochromatic light, and by casting another shadow by means of a candle alongside the first shadow, the intensities of the two lights which illuminated the two shadows could be compared by what they term an oscillation method. It is known that on each side of the yellow of the spectrum the luminosity more or less rapidly decreases. By placing a candle at such a distance from the screen that the luminosity of the two shadows appears as approximately equal, it is easy to oscillate the card carrying the slit through which the monochromatic rays of the spectrum pass. (The slit is in the focus of the lens which helps to form the spectrum.) The shadow of the rod cast by the candle can thus be made to appear alternately "too light" or "too dark" in comparison with the shadow of the rod cast by the parts of the spectrum falling on the screen. By a moderately rapid oscillation the position of equality of the two shadows can be distinguished with great exactness. The authors describe their method of fixing the position of the rays employed and the source of light with which the spectrum is formed. They also enter into details as to the comparison light, the receiving screen, and the comparative value of the light as seen by them respectively. The curve of the intensity of the spectrum of the light emitted from the positive pole of the arc light as seen by their eyes, which they call the normal curve, is then described. The question as to the effect of an alteration of the colour of the comparison light is then discussed, as is the effect of the brightness of the spectrum.

The next point touched upon is as to the value of mixed light as compared with its components. It is found that the following law holds good, viz.: *that "the sum of the intensities of two or more colours is equal to the intensity of the same rays when mixed."* This law is applied to Hering's theory of colour.

The authors next state that with the majority of people the curve of luminosity of the spectrum is identical with the normal curve, but that in some cases slight differences may be observed, of which one example is given. Such slight deficiency does not constitute colour-blindness, since the want of appreciation of any colour is but very partial. They next describe observations made by four colour-blind persons, and show that there is a remarkable divergence in their curves from the normal. The deficiency curves are shown, from which it appears that two of the observers are totally blind to red, whilst the other two are partially so. They then show that such observers would not give a true value for any light which is not of identically the same colour as the comparison light they might employ. It also appears that the intensity of illumination felt by a colour-blind is really less than that perceived by a normal-eyed person.

Two examples of the curves for sunlight are then given, one taken on a day in July by the method of separating close lines by varying the illumination, and the other in November by the method described above. Their results are compared with Vierordt's curve, obtained by extinguishing colour with white light.

In order to ascertain the effect of the turbidity of a medium through which light passes (for instance, of air on sunlight), the authors compared the intensity of the spectrum after passing through clear water and turbid water, and found that the absorption agreed with Lord Rayleigh's theoretical deductions that

$$I' = I_0 \epsilon^{-kx\lambda^{-4}},$$

where I′ is the intensity after passing through a turbid medium, I_0 the intensity after passing through clear water, x the thickness of the turbid layer, k a constant independent of λ, λ being the wave-length.

The authors conclude their paper with a discussion of the intensity curves of the spectrum of carbon filaments electrically heated.

Chemical Society, February 18.—Dr. Hugo Müller, F.R.S., President, in the chair.—The following papers were read:—The constitution of undecylenic acid as indicated by its magnetic rotation; and on the magnetic rotation, &c., of mono- and di-allylacetic acids and ethylic diallylmalonate, by W. H. Perkin, F.R.S.—Reactions supposed to yield nitroxyl or nitryl chloride, by W. Collingwood Williams, B.Sc.—The condition of silicon in cast iron, by A. E. Jordan and Thomas Turner.—Certain aromatic cyanates and carbamates, by H. Lloyd Snape, B.Sc.—The oil obtained from lime-leaves, by Francis Watts.

March 4.—Dr. Hugo Müller, F.R.S., President, in the chair.—A new element: germanium, by Clemens Winkler.—The influence of temperature on the heat of chemical combination, by S. U. Pickering.—The salts of tetrethylphosphonium and their decomposition by heat, by Prof. E. A. Letts and Norman Collie, Ph.D.—The formation of acids from aldehydes by the action of anhydrides and salts, and the formation of ketones from the compounds resulting from the union of anhydrides and salts, by W. H. Perkin, F.R.S.—A new method of preparing tin tetrethide, by Prof. E. A. Letts and Norman Collie, Ph.D.—Contributions to the history of cyanuric chloride, by Alfred Senier, M.D.—The action of naphthylamine on cyanuric chloride, by Harold H. Fries.—Sulphine salts containing the ethylene radicle; part i., diethylenesulphide-methyl-sulphine salts, by Orme Masson, M.A., D.Sc.—Sulphine salts containing the ethylene radicle; part ii., on Dehn's reaction between ethylene bromide and alkyl sulphide, by Orme Masson, M.A., D.Sc.

Zoological Society, March 16.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. F. D. Godman, F.R.S., exhibited some examples of a butterfly, *Danais plexippus*, from various localities, and made remarks on its distribution, which of late years seemed to have become very widely extended.—Prof. Bell made some remarks on the *Balanoglossus* recently discovered in the Island of Herm, Channel Islands, of which he had exhibited a specimen on a former occasion.—A communication was read from the Rev. H. S. Gorman, F.Z.S., containing descriptions of some new genera and species of Coleoptera of the family Endomychidæ from various localities.—A communication was read from Dr. R. J. Anderson, F.Z.S., of Queen's College, Galway, containing observations on the pelvisternum in certain Vertebrates.—Prof. F. Jeffrey Bell read a paper on the generic characters of Planarians, basing his observations mainly on a specimen of a Planarian recently found living in this country, and believed to be referable to *Bipalium kewense*.—Mr. F. E. Beddard read a note on the structure of a large species of earthworm from New Caledonia, of which examples had been recently received from Mr. E. L. Layard, F.Z.S., H.B.M. Consul for New Caledonia.

Physical Society, March 13.—Prof. Balfour Stewart, President, in the chair.—Prof. U. S. Pickering and A. C. Hayward were elected Members of the Society.—The following communications were read:—On the growth of filiform silver, by Dr. J. H. Gladstone. It has long been known that if a piece of metallic copper be placed in a solution of nitrate of silver, replacement of one metal by the other will take place, the silver being deposited in the crystalline form, sometimes having a resemblance to fern-leaves, or as superposed hexagonal plates, or knobs. It was observed, however, as far back as 1872, by the late Mr. Tribe and the author, that if nitrate of silver were decomposed by suboxide of copper instead of the metal, the silver presented itself in threads, which rarely, if ever, bifurcate, but frequently turn at sharp angles or twist in every direction. This was described in the British Association *Report* for 1872, and it was observed that the same forms occurred in native silver. More recent observations have shown that the particular character and rapidity of formation of these threads depend very much upon the strength of the solution and the condition of the suboxide. Hydrated suboxide will scarcely decompose a 2 per cent. solution, even after standing. The threads, which bend at a sharp angle, usually do so at 60° or 120°. Other threads, however, are symmetrically curved; but, especially in strong solutions, they are given to twisting about in every direction, and generally terminate in irregular knobs of silver. As a rule a thread continues to grow of the same thickness as it commenced, but it sometimes enlarges for a while into a flat plane, or becomes incrusted for some distance with small crystals of silver. When the solution is very nearly exhausted of silver, fine arborescent forms appear; but with the suboxide there are never produced the fern-leaved forms, or hexagonal plates, or the other distinctly crystalline structures which characterise the growth from metallic copper. During the reaction the suboxide is changed into black protoxide and metallic copper, which dissolves; and the change will take place as well with the acetate and sulphate as the nitrate. If a mixture of suboxide and metallic copper be employed, not only do the distinctly crystalline and the filiform forms make their appearance, but strange intermediate forms come into existence.—Apparatus for measuring the electrical resistance of liquids, by Prof. Reinold. The apparatus consists of two bottles connected by a horizontal tube. The whole is filled with the liquid to be examined, and immersed in water, by which means, and by thermometers inserted in each bottle, the temperature may be regulated and accurately ascertained. The electrodes are platinum plates, one dipping into each bottle. Two fine tubes terminate near the ends of the connecting-tube, and electrodes are fitted into them at some distance from the ends; by connecting these to a quadrant electrometer or a condenser and galvanometer, the difference of potential between the ends of the tube can be compared with that at the ends of a known resistance in the same circuit.—On chromatic photometry, by Capt. Abney and Lieut.-Col. R. Festing. (This paper had been previously communicated to the Royal Society.) A series of experiments have been made by the authors to determine the comparative luminous effect of different parts of the spectrum. A monochromatic light from any part of the spectrum of the electric arc was obtained by a method devised by Capt. Abney, and previously described by him to the Society [Physical Society, June 27, 1885, NATURE, vol. xxxii. p. 263]. The photometric effect at different parts of the spectrum was compared with that due to a candle at different distances by Rumford's photometer. In using this it was found best to place the candle in a given position, and obtain a balance by moving the slide upon which the spectrum was formed, and through a slit in which part of the light was allowed to pass rapidly to and fro. For each position of the candle there are thus two corresponding positions of the slit. From the results of these observations a curve may be drawn, showing the luminosity at different points. From the method by which it is obtained it is evident that the curve of one observer is not directly comparable with that of another, since a deficiency of perception in any part of the spectrum would affect the light of the candle as well as that examined. Since, however, the curves obtained by a great number of persons coincide very closely with those obtained by the authors, they have felt justified in adopting them as the normal curves. In the case of the electric arc the normal curve attains a maximum rather nearer the red end of the spectrum than the blue. Assuming the normal curve, any other curve may be compared with it by increasing or decreasing its ordinates, so that no part of it shall lie without the normal curve. In curves thus obtained, several of which were shown, deficiency in colour-perception is often very clearly marked. By the use or two or more slits in the movable slide, experiments were made upon mixtures of colours, and it was found in all cases that the luminous effect of a mixture of colours was the sum of the luminous effects of its components. It was also found that the colour of the comparison and the quantity of light admitted to form the spectrum were without effect upon the form of the curve. Light from the sun and from an incandescent lamp were similarly examined, though it should be observed that the result for sunlight differs notably from that given by Maxwell. An examination has also been made of light after passing through a turbid medium, and an expression of Lord Rayleigh's—

$$I' = Ie^{-x\lambda^{-4}},$$

where I is the original radiation, I' that after passing through the medium, λ the wave-length of the light, and x a constant depending upon the medium, has been closely verified.

Royal Microscopical Society, March 10. — Rev. Dr. Dallinger, President, F.R.S., in the chair.—Mr. J. Beck described his recent visit to the Naples Zoological Station, and exhibited some Tubularia and other organisms with expanded tentacles.—Dr. Crookshank exhibited an elaborate micro-photographic apparatus by Messrs. Swift.—Mr. Crisp exhibited Helmholtz's vibration-microscope for observing the vibration of tuning-forks, strings, and other bodies, Thoma's microscope for examining the circulation of the blood in the mesentery of dogs and other small mammals, and various other microscopes and apparatus, including Prof. Exner's new micro-refractometer for detecting differences in the structure of blood-corpuscles, insects' cornea, &c.—An important communication was read from Prof. Abbe, of Jena, announcing the construction of a new kind of glass, by which the secondary spectrum in objectives was eliminated. Two new objectives were exhibited, which were found to present a considerable advance upon those hitherto constructed.—Notes on a new mounting media of high refractive index, and on a process for obtaining diatoms, were read.—Mr. A. D. Michael read a paper on the life-history of an Acarus, one stage whereof is known as *Labidophorus talpæ*, Kramer, and on an unrecorded species of Disparipes. In 1877 Kramer described a creature which he found parasitic upon the mole, and treated as a new species, naming it as above; it resembled Koch's *Dermaleichus sciurinus*; it was, however, suspected that both were immature, hypopial forms. In 1879 Haller discovered the adult form of *D. sciurinus*; he found it upon the squirrel in considerable numbers and in all stages, Koch's supposed species being the hypopial nymph. For some years Mr. Michael has been trying to trace the history of Kramer's Labidophorus, which he frequently found on the mole, but which he could not get to thrive away from its host; less fortunate than Haller, he could not find on the mole any Acarus which could be the adult stage. Last December it struck him that he might succeed by getting the moles' nests; here he found adult males and females of what he thought might be the species; he also found immature Acari in the ordinary nymphal stage, which he suspected belonged to the same species. By keeping these in confinement and carefully watching them he was enabled actually to see the hypopial nymph, *Labidophorus talpæ*, emerge from the cast skin of the young ordinary nymph, and the adult males and females emerge from the cast skin of the fully-grown ordinary nymph. Mr. Michael proposes to call the species *Glyciphagus crameri*. It is a singular species, the males having remarkable comb-like longitudinal ridges under the front legs. Mr. Michael also described the life-history of a new Disparipes, to be called *D. exhamulatus*.

Anthropological Institute, March 9.—Mr. John Evans, F.R.S., Vice-President, in the chair.—The election of Maccullough Bey was announced.—Mr. Arthur J. Evans read a paper on the flint-knapper's art in Albania. During a recent journey through Epirus Mr. Evans was so fortunate as to observe, in a street of Joannina, an old Albanian flint-knapper practising his art, and described his method of working. The place where he obtained his flints is about two hours' journey from Joannina. The flints were mostly of tabular shape, scattered in profusion about the summit of a limestone plateau, but Mr. Evans was unable to discover any signs of their having been used for manufacture in ancient times. The strike-a-lights, as exposed for sale, are partially cased in ornamental lead sheaths studded with glass gems and otherwise adorned with something not unlike the ancient "honeysuckle" pattern. Compared with old English, French, and German forms, the Albanian flints show the peculiarity of being chipped on both faces instead of presenting one flat side, and they are fashioned with a minute care that recalls the beautifully even surface-chipping of Neolithic times.—The following communications were read by the Secretary:—Notes upon a few stone implements found in South Africa, by W. H. Penning, F.G.S.; and notes on some prehistoric finds in India, by Bruce Foote, F.G.S.—Dr. Garson exhibited and described Broca's stereograph and some other anthropometric instruments.

PARIS

Academy of Sciences, March 22.—M. Jurien de la Gravière, President, in the chair.—On the constitution of the earth's crust, by M. Faye. It is argued that the surface of the globe cools more rapidly and to a greater depth under the oceans than on the continents, because heat radiates more freely through liquid than through solid bodies. And as this discrepancy has existed for millions of years, the crust of the earth must now be denser under the waters than under dry land. Hence, in the pendulum observations and other calculations made relative to the figure of the globe, no account should be taken of the attraction of the continental masses lying above sea-level, this excess of matter being compensated lower down by a corresponding diminution of density. In the same way no account should be taken of the feeble attraction of the oceans, because this also is compensated a little lower down by the greater density of the solid crust under the oceanic basins. The same conclusion is pointed at by the now completed triangulation of India, Col. Clarke remarking that it would seem that these pendulum observations have established the fact (previously indicated by the astronomical observations of latitude in India) that there exists some unknown cause, or distribution of matter, which counteracts the attraction of the visible mountain masses.—On the flexion of prisms, by M. H. Resal. A source of error is detected and corrected in the memoir on the flexion of prisms published by M. de Saint-Venant in 1856, the last in which he occupied himself with the subject.—Description of an instrument intended to produce at pleasure an invariable quantity of electricity, by M. Marcel Deprez. This invention, which has already been successfully tested in several experiments conducted by M. Minet at Creil, has for its object the easy reproduction of the unit of electric quantity known by the name of *coulomb* at all times and under all conditions of temperature and pressure.—Account of a spherical absolute electrometer, by M. Lippmann.—Note on the poisons normally present in animal organisms, and particularly on those of the urine, by M. Ch. Bouchard.—On the development of a holomorphous function in a series of polynomes in any area, by M. P. Painlevé.—On the calorimetric study of metals at high temperatures, by M. Poinchon. In this paper the author continues the researches of Pouillet, Weber, and Violle, and here deals more especially with the common metals and some alloys of platina.—On effluvography, a method of obtaining images by effluvium, by M. D. Tommasi. The author submits the first results of his researches on a process for obtaining, by the sole action of electric effluvium, the effects realised by the employment of light in photography. His experiments tend to show that the effluvium produces the same effects as the ultra-violet rays, and that there must consequently exist a connection between the two extreme ends of the spectrum. This connection is constituted by what he provisionally calls *electric rays*.—On the separation and quantitative analysis of copper, cadmium, zinc, nickel, cobalt, manganese, and iron, by M. Ad. Carnot. Having already shown how copper may be separated from cadmium, and cadmium from zinc, by means of the hyposulphite of ammonia and soda, the author explains his process for separating zinc, nickel, or cobalt, manganese, and iron by means of sulphuretted hydrogen, the state of the liquids being modified by successive precipitation.—On the elements of sugar of milk in plants. In continuation of his previous paper the author shows that the mucous substances of plants, gums, pectine, mucilage, &c., contain galactose identical with that of the sugar of milk; and further, that these mucous substances exist in vegetable aliments in such quantities that they are able to furnish the galactose which enters into the constitution of the sugar of milk secreted by the mammary glands of herbivorous animals.—On a new organ of sense in *Mesostoma lingua*, Osc. Schm., by M. Paul Hallez. The organ here described as a median ventral fosse would probably seem to be the seat of the sense of smell in these organisms.—Chlorophyll and the reduction of carbonic acid by plants, by M. C. Timiriazeff.—Note on some xylenic derivatives, by MM. Albert Colson and Henri Gautier.—On the oxidation of the acids of fatty substances, by M. H. Carette.—On a synthesis of the cyanide of ammonium by effluvium, by M. A. Figuier.—Fresh researches on the toxic or medicinal substances by which hæmoglobin is transformed to methæmoglobin, by M. Georges Hayem.—Description of the excreting apparatus and nervous system of *Duthiersia expansa*, Edm. Perrier, and of *Solanophorus megalocephalus*, Creplin, by M. J. Poirier.—On the selenides of potassium and of sodium, by M. Charles Fabre. The formulas are given for the heat of formation and the heat of dissolution of these selenides.—On *Sigillaria Menardi*, in reply to the strictures of M. Weiss, by M. B. Renault.—On the disposition of the crystallised and archæan rocks in West Andalusia, by MM. Michel Lévy and J. Bergeron.—On the slope of the isothermal layers in the deep waters of the Lake of Geneva, which are shown to be inclined at an angle and not superimposed horizontally, as hitherto supposed, by M. F. A. Forel.—On the probable origin of earthquakes, by M. Ch. Lallemand. The author reverts to Elie de Beaumont's theory of a central fluid, which, in combination with Lowthian Green's more recent views on the chilling process ("Vestiges of the Molten Globe"), supplies, he thinks, an adequate explanation of all the underground phenomena and igneous eruptions.

BERLIN

Physical Society, January 8.—Dr. Lummer had subjected De Lalande's element to an examination, and communicated some provisional results of this investigation. The element consisted of an iron vessel, the bottom of which was covered with peroxide of copper; the neck was closed by an india-rubber stopper, through which a zinc cylinder passed; the fluid with which it was filled was potash lye. The chemical process in the cell consisted in the formation of zincate of potassium (*Kaliumzinkat*) and of metallic copper. The electromotory force of the element was found to be equal to from 0·5 to 0·8 Daniell. In one case, however, there were two elements which appeared perfectly alike, one of which yet showed an electromotory force of 0·8 Daniell, the other of more than 1 Daniell, though no ground for this difference was perceptible. The internal resistance of the element was found to be equal to about 0·1 Siemens, and the intensity of the current, the external resistance being 1 Siemens, was about 1 Ampère. Permanently closed with 1 Siemens, the element kept the same intensity for six full days. If the element was exhausted, the passage of a vigorous current from the dynamo-machine sufficed, according to the statements of the discoverer, to completely restore the element. This, however, could only happen, as Prof. von Helmholtz set forth at large in the discussion following the address, when such strong currents were applied that the iron became passive, and only the copper again got oxidised.—Prof. Börnstein reported on the sleety squall which blew through Berlin on January 5, at 2.20 p.m. He laid before the Society the curves marked at that time by the registering apparatus of the Agricultural High School of Berlin. The barograph first showed a sudden rise of about 1mm. in the pressure of the atmosphere. The thermograph marked just as sudden a depression of temperature. The anemograph indicated a sudden increase in the strength of wind, and at the same time a shower of sleet fell to the earth. The same day, at about 11.30 a.m., a squall was observed in Hamburg, which also coincided with a sudden rise in the pressure of the atmosphere and diminution of temperature. It was hardly to be doubted that this was the same squall which reached Berlin at 2.20 p.m., and which accordingly had overtaken the distance from Hamburg to Berlin in about 2¾ hours. In regard to the nature of these squalls, the speaker set forth the theory that they represented the state of the atmosphere after the occurrence of a small minimum with ascending current of air. On the back of this minimum the air fell to the ground, and produced both sudden rise of pressure and abatement of temperature, seeing that the upper cold air descended with its icy precipitate. The most important phenomena of the squalls—increase in pressure and in the strength of the wind, decrease of temperature and the precipitates—were in this way very readily explained. The somewhat lengthy discussion with which this address was followed up dwelt on the necessity of quite precise determinations of the time of each particular phenomenon embraced in the course of such a squall, in order to be able to distinguish the primary from the secondary phenomena, as also on the necessity of exactness in respect of the barographs, both quicksilver and aneroid.

BOOKS AND PAMPHLETS RECEIVED

BOOKS:—"Atlas de la Description Physique de la République Argentine;" Deuxième Section: Mammifères, by Dr. H. Burmeister (Buenos Aires).—"Calendar, Royal University of Ireland, 1886" (A. Thom).—"A Short Manual of Chemistry;" Vol. I. Inorganic Chemistry, by Dupré and Hake (Griffin).—"Burma," by J. G. Scott (Shway Yoe) (Redway).—"Upland and Meadow," by C. C. Abbott (Low).—"Manual of Surgery," 3 vols., edited by F. Treves (Cassell).—"Electricity," by L. Cumming (Rivingtons).—"Observations of the Southern Nebulæ made with the Great Melbourne Telescope from 1869 to 1885," Part I., by R. L. J. Ellery (Ferres, Melbourne).—"Mineral Resources of the United States 1883-84," by A. W. Williams, Jun. (Washington).—"The Fisheries and Fishery Industries of the United States;" Section I. Text and Plates, 2 Vols., by G. B. Goode (Washington).—"A Catalogue of the Library of the Chemical Society" (Harrison).—"Report of the Commissioner of Education, 1883-84" (Washington).—"The Cornell University Register, 1885-86" (Ithaca, N.Y.).—"A Treatise on Nature," by H. Collins (White).—"Euclid Revised," by R. C. J. Nixon (Clarendon Press).—PAMPHLETS:—"A New Graphic Analysis of the Kinematics of Mechanisms," by Prof. R. H. Smith.—"Die Ursache der Secularen Verschiebungen der Strandlinie," by Dr. F. Lörol (Prag).—"Goitre in the Himalayas," by W. Curran (Falconer, Dublin).—"Loss of Life and Property by Lightning at Home and Abroad," by W. McGregor (Robinson, Bedford).—"Report of Experiments on the Growth of Wheat," by Sir J. B. Lawes and J. H. Gilbert (Clowes).—"On the Valuation of Unexhausted Manures," by Sir J. B. Lawes and J. H. Gilbert (Murray).—"Experiments on Ensilage, Season 1884-85," by Sir J. B. Lawes and J. H. Gilbert (Harrison).—"Gyrating Bodies," by C. B. Warring.—"Liste Générale des Observatoires et des Astronomes, des Sociétés et des Revues Astronomiques," by A. Lancaster (Hayez, Bruxelles)

CONTENTS

THURSDAY, APRIL 8, 1886

KINSHIP AND MARRIAGE IN EARLY ARABIA

Kinship and Marriage in Early Arabia. By W. Robertson Smith. (Cambridge: University Press, 1885.)

IT is almost, if not quite, an act of presumption to attempt to review Prof. Robertson Smith's book. The subject (the development of the family in early Arabia) is exceedingly obscure. The evidence is mainly drawn from books whose very names I never heard of before. In matters of Greek and Roman antiquities the evidence is handy, and may be estimated by one who only knows the usual classical tongues. In matters of early India, we have, at least, the German translations of the Veda and Mure's Sanskrit texts to help us, and Prof. Max Müller's English works, and all that Bergaigne, and Whitney, and Barth have written. But Prof. Robertson Smith's Arabian writers are wholly inaccessible to the ordinary anthropologist. He cannot presume to criticise the sources and testimonies, and I make no such pretension. One has to take the author's statements as he gives them, with the confidence inspired by his great renown as an Orientalist, and by the assent which, it is understood, other famous Eastern scholars give to his method and conclusions.

The thesis maintained by Prof. Robertson Smith is that in Arabia, as elsewhere, the Patriarchal family, where it existed, grew slowly out of a system, commonly called the *Matriarchate*, in which women were the acknowledged permanent element in the household. Such families are familiar to readers of Mr. McLennan's books, and Prof. Robertson Smith, on the whole, is chiefly occupied here in extending the sphere within which Mr. McLennan's opinions hold good. A period of promiscuity, or at least of brief informal unions, was succeeded by an age of polyandry, and consequent doubtfulness about male parentage in each case. This condition was gradually modified, for example, by brothers sharing the same wife, till the patriarchal family emerged from the confusion. Stocks of kindred were not so much gentes, like those of Rome, but totem kindreds, with relationship and the totem and family name descending through the woman, and, of course, with the exogamous prohibition against marriage between a man and woman of the same totem.

These, roughly, are the conditions whence, in early Arabia, Prof. Robertson Smith thinks that marriages and families with the husband and father for recognised centre were evolved. In many savage lands it is certain, in some civilised lands it is probable, that affairs have taken this course. But there is a very strong disposition to resist this conclusion among scholars who had it put before them rather late in life, when new ideas are distasteful. The existence of an older generation of doubters is most profitable to science. They exercise a constitutional check, and demand that proofs shall be very clear and unmistakable before they give up their old opinions. I do not expect Prof. Robertson Smith to make converts among the devotees of an original primæval patriarchal family. On the other hand, in my own case, he is "preaching to a proselyte." I am convinced that the order of development in which he believes has been very common if not universal. I think his theory colligates a great number of curious facts, and explains them at one stroke; whereas, if his theory is *not* accepted, I fail to see any one hypothesis, on the other side, that meets all the cases. These old survivals of customs will have to receive each its separate solution, or to be left unexplained as mere sports and curiosities. But, if Prof. Robertson Smith is right, they all fall into their proper strata, venerable fossils left by the tide of social progress, examples of laws known to have worked elsewhere to similar results. This appears to be an argument in favour of Prof. Robertson Smith's hypothesis.

When the Prophet started on his career, the unit of Arab society was the local group, feigned by genealogists to be a patriarchal tribe with a common ancestor. But the common ancestor's name often shows him to have been a fiction. "Many tribal names are plainly collectives." Some are plural animal names—Panthers, Dogs, Lizards—exactly such as we find in America, Africa, Australia, and India. Now, in these countries, the groups bearing such names are demonstrably *not* patriarchal, and demonstrably did grow up through exogamy and female kinship. If the similarly-named Arab tribes grew up differently, grew up on patriarchal lines and male kinship, the presence of beast names, like totem names, is a very curious coincidence. On the other view, Leopard, Wolf, Lizard was the name of the original or ideal ancestor. Now animal names as Christian names (so to speak) for individuals are common among savages. The personal name of a Red Indian whose totem and family name is "Crane," may be Wolf or Lizard. But as far as I know the *personal* name—the Christian name as it were—is always accompanied by an epithet, "Spotted Dog," "Sitting Bull," and the like, while the family or totem name is the beast, or plant, or another name *sans phrase*. For this reason I am disinclined to share Mr. C. J. Lyall's doubts (*Academy*, March 6, 1886). I think when an individual man has a personal name derived from a beast, it is a name with a qualification, as a rule. To a kindred calling themselves "Spotted Dogs," I would allow their claim to descend from a gentleman named "Spotted Dog," but a tribe called "Dogs" have a very totemistic air. However, so far, there is no certain demonstration. Arab tribes have many other names, divine or local, which cannot be derived from an actual ancestor. For these and similar reasons, Prof. Robertson Smith rejects the patriarchal origin of the several tribes, as conventionally given by genealogists. That explanation naturally occurred to men living in a state of male kindred, and the patriarchal family, but that explanation explains nothing. It does not, *e.g.*, explain tribes which refer their origin to a female eponym, an eponymous heroine. Nor does it explain why the Arab technical term for clan means "belly," just as, among aboriginal tribes of India, the native name for clan means "motherhood."

If we now examine marriage law, we find that by the prevalent type a woman goes to her husband's kin, and *her* children are reckoned of *his* blood, and take the side of *his* clan. But there are proofs that the opposite, the anti-patriarchal system, once existed. The man went to the woman's people (either permanently or on visits), and *his* children were reckoned to *her* blood, and took the side of *her* clan. Even now, among the Bedouins, a woman, it seems, rarely leaves her tribe, but strangers readily marry and settle in the tribe of their brides.

In the fourteenth century, a wife of the women of Zebîa would never follow a stranger husband, and she kept the children. The women of the Jâhîlya had the right to dismiss their husband, *the tent was theirs*. Ammianus mentions the gift of the wife to the bridegroom, a spear and a tent, he dwelt in *her* tent, and followed her people to the washing of spears. All this means *beena* marriage, as it is called in Ceylon. In marriages by capture, necessarily, the opposite rule prevailed. A woman went with the husband to his people, he is her lord, or *ba'al*, and thus *ba'al* marriage is the reverse of *beena* marriage. Purchase of wives naturally produced marriages of a *ba'al* type. As the two latter forms of marriage prevailed, women lost that independence in the wedded condition which they had enjoyed under *beena* marriage, thanks to the kindred of their own blood who surrounded them. Prof. Robertson Smith goes on to show the existence of various shapes of polyandry in early Arabia; there were "small sub-groups having property and wives in common as in Tibetan polyandry." In short, at the Prophet's time, the Arabs had already the orthodox family system with a paterfamilias, but previously there had been a system with a materfamilias, the house and children were hers, succession was through mothers, and the husband came to the wife, not the wife to the husband. The end of the book (Chapters VII. and VIII.) deals with traces and survivals of totemism. A list of tribal names derived from animals is given: the evidence that the animals were totems, worshipful, and not to be slain or eaten, is, naturally, scanty. In fact, though the analogies strongly point to the existence of totemism at a remote period in Arabia, I do not think the evidence will have much effect on the minds of the people who dismiss totems with the remark that they should be spelled *otes* or *otems*. A note (2, p. 221, see p. 304) is more to the point and more convincing. This note is of great religious interest and importance.

The tendency of the book, on the whole, is to show that among the Semitic races, as among Red, Black, and Yellow men, the matriarchal preceded the patriarchal family, and the totem kindred preceded the *gens*. That is precisely what one believes, but it is not in this generation that the doctrine will be universally accepted. In the case of Arabia proof is peculiarly difficult, as the reforms of the Prophet did so much to veil the remains of earlier religion and custom. It would be superfluous to praise a book so learned and masterly as Prof. Robertson Smith's; it is enough to say that no student of early history can afford to be without "Kinship in Early Arabia."

ANDREW LANG

FIELD'S CHROMATOGRAPHY

Field's Chromatography; a Treatise on Colours and Pigments, for the Use of Artists. Modernised by J. Scott Taylor, B.A. (London: Winsor and Newton, 1885.)

The Artists' Manual of Pigments. By H. C. Standage. (London: Crosby Lockwood and Co., 1886.)

THE new edition of "Field's Chromatography" differs in two important particulars from the previous issues of this well-known treatise. Firstly, one-third of the volume is devoted to a discussion of such parts of the modern theory of chromatics as bear upon the practice of the painter; secondly, a large number of useless or disused pigments and of substances suggested for use as pigments have been excluded from the pages before us. In accuracy and compactness this hand-book has undoubtedly been much improved, but it affords the student very little information upon two of the most important aspects in which artists should study their paints—those, namely, of purity and permanence. For instance, we are informed on p. 72 that "the artist will be told all that is known, outside manufacturing circles, of the constitution of his pigments." How is this promise redeemed? We turn to the description of white lead (pp. 97–101);—not a word can we find as to the presence in it of intentional adulterants or of such a frequent and injurious impurity as lead subacetate. We search in the same way and with the same result for some of the most rudimentary scraps of information as to the chemical characters and tests for the purity of vermilion, cadmium yellow, and artificial ultramarine. Then too we find statements as to individual pigments which are positively incorrect. It is not strictly true that the Naples yellow now sold is an imitation of the original pigment. One London house sells the original pigment—an antimoniate of lead, another supplies an equally good paint in which some oxide of zinc is associated with the antimoniate; neither preparation is an "imitation," made, say, with cadmium yellow and zinc white, and falsely called "Naples yellow." The question of permanence is not adequately discussed in this volume. We want numerical values representing the degrees of change suffered by those pigments with which the artist cannot dispense but which are known to alter under exposure. For example, it is misleading to call brown madder "very permanent" (p. 155): let any one try the effect of an exposure to a single summer's sunshine of a wash of this paint on a sheet of pure white paper. The same criticism applies to the statement (on p. 115) that the madder lakes are "not liable to change by the action of light." Certainly they cannot be termed fugitive in the same sense as the cochineal lakes, but they are by no means permanent. The editor of "Field's Chromatography" should have given more attention to gradations in the amount and nature of the colour-changes suffered by comparable pigments. In the tables of pigments in the appendix (pp. 171–185) no distinction is made between pigments used as oil-colours and those employed in water-colour drawings, although it is notorious that the medium has a marked effect upon the degree of stability shown by many pigments. And we altogether object to the accuracy of Table IV. (p. 176). Several of the pigments named in that list are entirely unaffected "by admixture with ochres and other ferruginous substances" instead of being "decomposed" by them as there stated.

The second work on our list has very slight claims on our attention. Mr. Standage's "Manual of Pigments" is stated on its title-page to show the composition of pigments, their degrees of permanency, their adulterations, and their mutual action; it also offers "the most reliable tests of purity." But when we examine into the chemical details given under the heads of the individual pigments we find that this compilation teems with the most ludicrous blunders. We proceed to cite a few of these, which need neither note nor comment in order to be fully appreciated by our scientific readers. On p. 1 we are informed that baryta white (barium sulphate) "consists of 137 equivalents (!) of barium, 32 equivalents of sulphur, and 64 equivalents of oxygen." On p. 3 we are furnished with an elegant test for the detection of free sulphuric acid in baryta white; we are directed to "add a few fragments of loaf-sugar to a largely diluted *solution* of the pigment, and evaporate to dryness. A black charred residue indicates free sulphuric acid." We are told (p. 7) that calcium imparts a *green* coloration to the blow-pipe flame. In testing verdigris for sulphate of copper we are informed (p. 21) that "sulphuretted hydrogen will throw down the *sulphur* present in it." Cœruleum (oxides of tin and cobalt) is stated to be made (p. 26) of "carbonate of soda 15 parts, powdered flint 20, and copper 3." Thénard's cobalt blue is "a salt of calcium calcined with alumina or oxide of tin" (p. 27). Indian yellow (p. 39) is "uriophosphate of lime" identical with "a magnesium salt of a curious acid called euxanthic." In order to see whether cadmium red (p. 47) contains any lead, "mix with white lead (!), boil in water, and add SH_2 to the solution." Red lead is said (p. 55) to undergo a "rapid oxidation" when mixed with sulphuretted hydrogen. Vermilion "must not be used with iodine" (p. 58). When chromate of lead is mixed with sulphide of cadmium, sulphide of lead is formed, and chromium, oxygen, and metallic cadmium are set free (p. 74). The iron in yellow ochre will if mixed with Naples yellow (antimoniate of lead) abstract oxygen from the latter and become deeper in tone (p. 76). Enough of Mr. Standage's chemistry: one line as to the value of his statements as to the theory of chromatics. On p. 81 he is good enough to inform us that from his own knowledge of colour-science he remains "steadfast to the old original theory of red, yellow, and blue being the three primaries."

We should not have devoted so much space to this curious little book if the present issue had been a first edition. But the majority of the extraordinary statements cited above were published by Mr. Standage in a work called the "Artists' Table of Pigments," of which the "Artists' Manual of Pigments" is to be regarded as a revision and enlargement.

OUR BOOK SHELF

American Journal of Mathematics, vol. viii. Nos. 1 and 2. (Baltimore, 1885, 1886.)

THIS volume opens with a memoir by Capt. MacMahon, R.A., on seminvariants, in which the author continues the discussion of the asyzygetic seminvariants commenced by him in vol. vi., No. 2 (see also vol. vii. No. 1). Mr. J. Hammond contributes "Syzygy Tables for the Binary Quintic." One table replaces in part the enumeration given by Prof. Cayley in his tenth memoir on Quantics (*Phil. Trans.*, part 2, 1878) and that given by Prof. Sylvester (*Amer. Journ*, vol. iv. p. 58). The same writer has two papers in No. 2—one "On Perpetuants, with Applications to the Theory of Finite Quantics," this is a subject familiar to the readers of the *Journal* through Prof. Sylvester's brilliant papers, and is handled in the author's usual accurate and clear manner; the second paper is on "The Cubi-quadric System," and is likewise a following out of previous papers in the *Journal* the size of whose paper is admirably suited for such lengthy and wide tables. P. Seelhoff has two papers on the theory of numbers, "Prüfung grösserer Zahlen auf ihre Eigenschaft als Primzahlen" and "Nova methodus numeros compositos a primis dignoscendi illorumque factores dignoscendi." The first is a continuation of a paper in vol. iii. No. 3, and puts in the forefront a remark of Mr. Glaisher's: "The process of determining without a table the factors of a number is excessively laborious. Thus to determine, for example, whether the number 8559091 is or is not a prime, would require a long day's work." Upon this the writer remarks "Sehen wir zu!" There are ten pages of tables. The memoir by Dr. Emory McClintock entitled "Analysis of Quintic Equations," is a very interesting and apparently thorough discussion of the subject, with full historic references. Dr. T. Craig contributes a paper "On Linear Differential Equations whose Fundamental Integrals are the successive derivatives of the same function." This paper runs on into No. 2. The same writer closes the number with a memoir "On a Linear Differential Equation of the Second Order." Messrs. E. H. Moore and C. N. Little, in their "Note on Space Divisions," follow on the lines of Pilgrim's "Ueber die Anzahl der Theile, in welche ein Gebiet k^{ter} Stufe durch n Gebiete $(k-1)^{ter}$ Stufe getheilt werden Kann," and discuss the division of flat space of k dimensions by flat spaces of $k-1$ dimensions. In a "Note on a Roulette" Dr. A. V. Lane discusses that generated by the rolling of an ellipse on a right line, one extremity of the major axis being the generating point. Mr. H. B. Fine contributes a paper "On the Singularities of Curves of Double Curvature," and Mr. J. C. Fields has a notelet, "Proof of the Theorem—the equation $f(z) = 0$ has a root where $f(z)$ is any holomorphic function of z."

Burma, as it was, as it is, and as it will be. By James George Scott ("Shway Yoe"). (London: George Redway, 1886.)

MR. SCOTT'S position as a competent and instructive writer on Burma was assured by his volume on "The Burman; his Life and Notions," published a few years ago. In this work he showed an intimate knowledge of the habits and modes of thought of the Burmese which could only have been acquired by a mastery of the language and a familiarity with the inner life of the people such as few Europeans can obtain of any Oriental nation. The present work is, no doubt, published in view of recent political events which have naturally attracted public attention especially to Upper Burma. In it the reader will find the whole subject treated in a general way, the first section being devoted to history, the second to geography, the third to "the people," under which head we find information respecting the method of administration, the religion, superstitions, and social habits of the Burmese. It is inevitable that the book should have a somewhat encyclopædic air, but Mr. Scott's entertaining style should gild the pill for the "general reader." Moreover, there are no really popular books in which the comprehensive information here given can be obtained in English. The average reader can hardly be expected to master the large works of Fytche, Yule, Crauford, and others, merely in order to get some accurate information about one small portion of the British Empire. In this respect the book is of a kind more familiar to French than to English readers; but it is much more than a mere catchpenny publication to meet a superficial and temporary demand. Readers of this journal, for example, may find much in it of special interest to them. The sketch of Burmese cosmogony and mythology is very interesting. The story of the forbidden fruit is familiar in Burma, the place of the apple being taken by the seeds of a species of creeper, and the fall being gradual instead of immediate.

Another point of much importance at the present moment is dealt with at comparative length. We refer to the hill-tribes in the mountainous region to the north of Burma, and especially between Bahmo and Momien. These call themselves by many different names, Chyens, Kyaws, Paloungs, Khamis, Mros, &c., but a closer examination of dialects, and especially of traditions and customs, proves, says Mr. Scott, that they are merely waifs and strays from the four main stocks, Burmese, Peguan, Karenns, and Shans. The Salones of the Mergui archipelago, some of the Arakan hill-tribes, and the notorious Kachyens in the north, are apparently exceptions, but all the others belong to one or other of these four families. The Kachyens just mentioned are so called by the Burmese; they call themselves Singpho, or Singpaw, which means simply "men." Ethnologically they are a branch of the Singphos proper, who inhabit the northern Assam hills, and are better known to us by their local names of Gáros and Nagas. Such at least is Mr. Scott's account of them; but it is quite clear that the last word has yet to be said by ethnologists about these and other tribes adjoining our new territory. The last pages of the volume are devoted to an account of the habits, manners, superstitions, &c., of these hill-tribes. The writer would probably be the last to expect a very high position for this volume as one of original research or information; but he may fairly claim to have performed a task of much usefulness and interest in a thorough and workmanlike manner. He has placed within easy reach of his countrymen sound and accurate information about a region for the peace, order, and good government of which they have now assumed the responsibility; and Mr. Scott's own previous writings are mainly responsible for having deprived part at least of the present book of the merit of originality likewise.

Marvels of Animal Life. By Charles Frederick Holder. (London: Sampson Low, Marston, and Co., 1886.)

THE author, during a long residence among coral reefs somewhere on "our southern border"—we have failed to find exactly where—studied very diligently the various forms of marine life abounding in such places, and he seems to have been attracted more especially to the study of the fishes. From the interesting records of these observations to be found in this little volume there can be no doubt that Mr. C. F. Holder has been a close and intelligent student of nature, and he has grouped the observations of others with his own in a manner to make the record fairly interesting reading to a specialist. To the wider field of young students some of the escapes from whales and swordfish will prove even exciting reading, while, so far as we can judge, none of the chapters convey erroneous or exaggerated views of the marvels of animal life. The illustrations, of which there are thirty-one, in the form of plates, are often rather sensational, and the majority of them would hardly be claimed as after nature. The work is sure to be popular, from the very novelty of the subjects about which it treats.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Integer Numbers of the First Centenary, satisfying the Equation $A^2 = B^2 + C^2$

I HAVE sometimes wished to refer to the principal integer numbers which satisfy the equations $A^2 = B^2 + C^2$, and I have computed all in which the leading numbers rise to and slightly pass the value 100. Perhaps they may interest some of the readers of NATURE.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	5	13	17	25	29	37	41	53	61	65	65	73	85	85	89	97	113	145
B	4	12	15	24	21	35	40	45	60	56	63	55	77	84	80	72	112	144
C	3	5	8	7	20	12	9	28	11	33	16	48	36	13	39	65	15	17

In mechanical applications of these numbers, it is usually desirable to select those in which the proportion $B : C$ differs least from 1. I place, below, the numbers B and C arranged in the order of value of the fraction $\frac{B}{C}$.

No. in order of value of $\frac{B}{C}$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
B	21	72	55	4	45	56	15	80	77	12	35	24	63	40	60	84	112	144
C	20	65	48	3	28	33	8	39	36	5	12	7	16	9	11	13	15	17
$\frac{B}{C}$	1·05	1·11	1·14	1·33	1·61	1·70	1·87	2·06	2·14	2·40	2·92	3·43	3·94	4·44	5·45	6·49	7·47	8·49
Original order	5	16	12	1	8	10	3	15	13	2	6	4	11	7	9	14	17	18

White House, Greenwich, March 31 G. B. AIRY

The Sunrise Shadow of Adam's Peak, Ceylon

SOME of the phenomena of the shadow of Adam's Peak in the early morning have been remarked by almost every traveller who has visited this island. The mountain rises to a height of 7352 feet as an isolated cone projecting more than 1000 feet above the main ridge to which it belongs. The appearance which has excited so much comment is that just after sunrise the shadow of the Peak seems to rise up in front of the spectator, and then suddenly either to disappear or fall down to the earth.

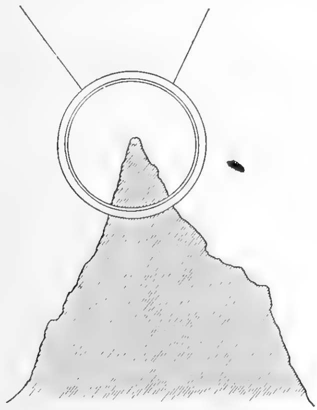
Various suggestions have been made as to the source of this curious shadow; among others one, which was published in the *Phil. Mag.*, August 1876, that attributed the rise of the shadow to a kind of mirage effect, on the supposition that the air over the low country was much hotter than on the Peak top.

I determined to attempt the discovery of the true nature of this appearance, and was fortunate to see it under circumstances which left no doubt as to the real origin. Through the courtesy and hospitality of Mr. T. N. Christie, of St. Andrew's Plantation, I was able to pass the night on the summit, and to carry up a few necessary instruments.

The morning broke in a very unpromising manner. Heavy clouds lay all about, lightning flickered over a dark bank to the right of the rising sun, and at frequent intervals masses of light vapour blew up from the valley and enveloped the summit in their mist. Suddenly, at 6.30 a.m., the sun peeped through a chink in the eastern sky, and we saw a shadow of the Peak projected on the land; then a little mist drove in front of the shadow, and we saw a circular rainbow of perhaps 8° or 10° diameter surrounding the shadow of the summit, and as we waved our arms we saw the shadow of our limbs moving in the mist. Two dark lines seemed to radiate from the centre of the bow, almost in a prolongation of the slopes of the Peak, as in the figure.

Twice this shadow appeared and vanished as cloud obscured the sun, but the third time we saw what has apparently struck so many observers. The shadow seemed to rise up and stand in front of us in the air, with rainbow and spectral arms, and then to fall down suddenly to the earth as the bow disappeared. The cause of the whole was obvious. As a mass of vapour drove across the shadow, the condensed particles caught the shadow, and in this case were also large enough to form a bow. As the vapour blew past, the shadow fell to its natural level—the surface of the earth.

An hour later, when the sun was well up, we again saw the shadow of the Peak and ourselves, this time encircled by a



Shadow, circular rainbow, and dark radiating lines of Adam's Peak.

double bow. Then the shadow was so far down that there was no illusion of standing up in front of us.

I believe that the formation of fog-bow and spectral figures on Adam's Peak is not so common as the simple rising up of the shadow, but one is only a development of the other. In fine weather, when the condensed vapour is thin and the component globules small, there is only enough matter in the air to reflect the Peak shadow in front of the spectator, and no figure is seen unless the arms are waved. In worse weather the globules of mist are large enough to form one or two bows, according to the intensity of the light. We were fortunate to see the lifted shadow accompanied by fog phenomena, which left no doubt as to the cause of the whole appearance.

Any idea of mirage was entirely disproved by my thermometric observations, which cannot be detailed here for want of space. RALPH ABERCROMBY

Colombo, February 25

"Bishop's Ring"

THE critique on Dr. Riggenbach's pamphlet on the Krakatão dust-glows alludes to the peculiar ring since seen surrounding the sun, and known as "Bishop's Ring," as though it had ceased to be visible last year. But the peculiar pink-tinged area surrounding the sun has been constantly seen since then, though perhaps without so definite a succession of tints as to deserve the title of "halo." On almost any day when the sun is hidden by a dense cloud so that the direct light is greatly subdued, there will appear, surrounding the cloud, an area at first intensely white, and then passing into a definite pink tinge. I saw this phenomenon very markedly this afternoon at 5.10 p.m., when walking across the fields from Swinggate, a hamlet between here and Dover, towards the Cornhill Coastguard Station. I have always observed it better when there is a strong southwest wind blowing. Does this mean that the great mass of the dust-particles is still in equatorial regions? Though the phenomenon to which I allude is undoubtedly best seen when the sky has that gray tinge which accompanies a saturated or super-saturated condition, I can hardly think it due to moisture. I did not observe it till after the Krakatão eruption, and I have observed it constantly since that outbreak. Perhaps condensation of moisture in the upper aërial regions may result in the formation of minute particles of water to which the dust-particles become attached, and thus both water and dust may be concerned in the production of the pink-tinged area. EDWARD F. TAYLOR

St. Margaret's-at-Cliffe, Dover, March 29

"Ferocity of Rats"

IN reference to the correspondence that appeared in last week's issue (p. 513) upon the above subject, permit me to state I have found by practical experience that the ferocity and voracity of rats is very great. They devour one another at all times and under all circumstances, whether living in a wild state or under the influence of domestication. I kept six rats at one time in confinement, and although well fed, the largest specimen consumed all the rest. Again, shortly after the late Inventions Exhibition closed last year, the following incident came under my notice, which fully confirms me in the belief I have expressed. As I was passing through the building I heard wild and piteous cries issuing from a spot close to where I stood. I immediately proceeded thence, and beheld six large rats feasting upon three of their congeners not much smaller than themselves, who were endeavouring to free themselves from the sharp teeth of their assailants. All of these rodents appeared thin and wild, and were no doubt rendered bold and desperate by privation, for my presence had no effect upon their carnivorous attacks. I frequently hear rats scampering beneath the floor of my office, accompanied by loud and protracted squeals; and, after what I saw, I am induced to believe that a deadly raid is on such occasions being made upon one or more of them.

W. AUGUST CARTER

The Claylands, South Norwood, April 5

Weather in South Australia.—Stevenson's Thermometer-Screen

LATELY the conditions of weather on the Adelaide Plains have been so very interesting to the English meteorologist that a few figures will doubtless be acceptable to readers of NATURE. On February 18 the shade-maximum temperature at this observatory was 105·5 during a barometric depression. This was followed by a minimum of 48°·7 accompanying a barometric crest on the morning of the 21st, a range of 56·8 within three days. Again, at 3 p.m. on the 18th the dry bulb read 105°·5, and wet bulb 69°·1, giving the extraordinary difference of 36°·4. These figures actually give 9 as the percentage of relative humidity, according to Guyot. The instruments are exposed in an enlarged Stevenson screen, which answers admirably in this climate; and what can be a better test? I may add that I also have a small "Stevenson," of the pattern usually employed in England, with duplicate instruments. The differences between the two usually amount to merely a few tenths of a degree. The Hon. Ralph Abercromby, who visited my observatory a short while ago—since my return from Queensland—was much pleased with the result of my comparison. I reserve a table for the Royal Meteorological Society, but I may mention that I claim to have proved that Mr. Stevenson's screen is in every way suitable for the hot and dry climate of this continent. I am strongly of opinion that this screen, in its enlarged form, should henceforth be universally employed to secure *uniformity* of exposure—a desideratum of the very highest importance. I have strongly recommended its adoption throughout Queensland. I have found no trace of undue heating of the internal louvres, even under temperatures over 100°. CLEMENT L. WRAGGE

Torrens Observatory, near Adelaide, South Australia, March 1

"Radicle" or "Radical"

MAY I utter a word of protest against a common, but (as I venture to think) erroneous way of spelling the above word when used in its ordinary chemical sense of a root (Latin, *radicula*), basis, or common ingredient of a series of chemical compounds?

Surely the word is a substantive, and, like similar derivatives, should be spelt "radicle," and not as the adjective "radical." I hope, however, that those who spell it in the latter way will be able to adduce a partic*al* of reasoning in favour of their practice.

I am quite aware of the existence of a "leading artic*al*" called a "Radical" in politics; but in this case there is reference to one who desires a "radical" change in existing institutions. If, however, we are to consider him as "a common ingredient in a series of Caucuses," then I should maintain that here also the spelling should be amended. H. G. MADAN

Eton College, April 5

An Earthquake Invention

REFERRING to Prof. Milne's letter in NATURE of March 11 (p. 438), I have to say:—(1) That what I, as representing my father, have to complain of is that in a British Association Committee's Report describing experiments made with an aseismatic arrangement, and which appeared in the *Transactions* of the British Association of 1884, the writer thereof, who appears to have been Prof. Milne alone, did not acknowledge that Mr. David Stevenson had invented, described, and constructed precisely such apparatus in 1868, facts which Prof. Milne cannot deny, and yet took the honour to himself; and, when this was pointed out, he then set up a claim for Mr. Mallet which Mr. Mallet assuredly never made, and would have been the first to repudiate.

(2) Prof. Milne in that Report praised the aseismatic joint as a most useful invention, introducing a new and valuable principle of construction for earthquake-affected countries, and though he may now think otherwise, yet the account given in the Tsugisaki light-keeper's letter, quoted by him, of the effects of a shock at that lighthouse, in place of showing the uselessness of the apparatus, in my opinion proves the reverse, as the shock is reported to have been very severe; and had there been no aseismatic joint under the illuminating apparatus, it would have been so seriously damaged as to have been rendered useless, in place of which the light was only extinguished for five minutes.

Mr. Stevenson, in his original paper, with characteristic caution, carefully calls it an apparatus to *mitigate the effect of earthquake shocks*. Mr. Kinjero Fugicura, Engineer in Chief to the Lighthouse Department of Japan, writing January 11, 1886, says he is unable at present to give any definite opinion as to the merits of the aseismatic arrangements, because, since he put them in operation when he became Engineer in Chief, the occurrence of earthquakes has been very rare indeed; and further, he is of opinion that really to get at the bottom of the matter, two experimental tables would have to be placed at the same locality side by side, one with the aseismatic arrangements, and the other fixed, so that the behaviour of the two tables might be directly compared. To which I might add that the whole lighthouse (or any building of equal size), like that constructed and sent to Japan by my father, but which was unfortunately lost at sea, should be rebuilt and tried against ordinary houses unprovided with my father's invention.

(3) Prof. Milne asks what I claim as coming under Mr. Stevenson's invention. I claim of course everything which employs the same principle, and most distinctly the house carried on shot or "*cast-iron sand*," as Prof. Milne calls it, and which he lately erected in Japan, as well as the building described by him in the B. A. Report, p. 248, for 1884, as "resting on four cast-iron balls," and the action of which has been so perfect as to have actually "destroyed" all the "sudden motion or shock," and recorded by him as a notable earthquake.

I will not further trespass on your space, but refer your readers to the former correspondence on this subject in NATURE.

D. A. STEVENSON

84, George Street, Edinburgh, March 22

DR. T. SPENCER COBBOLD, F.R.S., F.L.S.

DR. COBBOLD was the son of the Rev. Richard Cobbold of Wortham in Suffolk. He was born in 1828, and educated at Charterhouse. He matriculated at the University of Edinburgh in November 1847, after having, in accordance with the mode of preparation for the profession of medicine then regarded as most advantageous, served a three years' apprenticeship with Mr. Crosse of Norwich, one of the most eminent and distinguished surgeons of his time. He thus came up to the University provided with a large amount of practical information, and even as a first year student possessed great dexterity in dissection and in the making of museum preparations, and was a skilful draughtsman. After working diligently for a year under Prof. Goodsir, he was appointed by that great anatomist as his prosector, and under his influence was led to abandon practical medicine for the more attractive study of morphology; his first original research being an anatomical essay on the Canal of Petit, which he offered as his graduation thesis, and for which a gold medal was awarded him by the Medical Faculty.

Like all other earnest Edinburgh students of that time he took an active part in the debates of the Royal Medical Society, and became in 1852 its senior President. In the same year, not many months after his graduation, he was appointed Curator of the Anatomical Museum, and became a prominent leader in the biological work of the School. As Curator he gave lectures on comparative osteology, and added largely to the collections. He also worked out the material for his article "Ruminantia," which appeared in the "Cyclopædia of Anatomy and Physiology" in 1856.

In 1856 Dr. Cobbold removed to London, and soon afterwards began to devote himself to the study of animal parasites, and particularly to the experimental investigation of their life-history, on which subject he made during the following years a number of important communications to the Linnean and other Societies. In 1864 his well-known work on "Helminthology" appeared, to which in 1869 he added a supplement containing his later researches. He subsequently published a manual of the parasitic diseases of domestic animals, a work on the grouse disease, and various other works relating to diseases of the same class.

In 1868 he was appointed by the Trustees of the British Museum to the Swiney Professorship of Geology, to which subject he had been led, under the influence of Prof. Edward Forbes, to devote much attention during his residence in Edinburgh. The greater number of these lectures were given at the Royal School of Mines, and were largely attended.

Dr. Cobbold's reputation as a comparative pathologist will rest on his treatise on the Entozoa. His most important contributions to morphology are his article on Ruminantia, his experimental researches on *Tænia mediocanellata* and other Cestodes, on Trichina, and on *Distoma hæmatobium*, and his recent paper on the parasites of elephants. His last communication to the Linnean Society was read on March 4.

THE GEOLOGISTS' ASSOCIATION AT THE SCIENCE SCHOOLS

ON Saturday, March 20, a party of over a hundred members of the Geologists' Association visited the Science Schools at South Kensington, by permission of the Science and Art Department, and were conducted over the building by Prof. J. W. Judd, F.R.S. The visitors met in the entrance-hall at 2.30, and then seated themselves in the large Chemical Lecture Theatre, where Prof. Judd gave a sketch of the history and development of the Schools and of the methods of study therein followed. At the conclusion of this address the party walked slowly through the various laboratories and lecture-rooms—metallurgical, physical, and chemical—gradually ascending to the upper stories of the lofty building, where are situated the biological and geological rooms. In one of them a large collection of apparatus employed in various parts of the course was laid out.

Although not termed a museum, the teaching collections of minerals, rocks, fossils, &c., at the Science Schools are sufficiently full and complete for the most advanced student. Some time was spent in these rooms; as many of the members of the Association are engaged in teaching science they examined the arrangements with much interest. The elementary collections, which every student is required to know thoroughly, are arranged in table-cases always open to inspection; the more advanced collections are in drawers beneath. Over the table-cases and drawers which contain the fossils there are coloured vertical sections and diagrams of the geological formations and their subdivisions, showing the variations in their development in different districts.

In the Biological and Geological Lecture-Room an address was delivered by Mr. G. A. Cole, Prof. Judd's chief assistant, on "The Preparation of Microscopic Sections of Rocks and Minerals," illustrated by the apparatus employed and by drawings upon the blackboard.

From the lecture-room the party passed into the biological laboratory, upon the table of which, for this occasion, were placed a large number of microscopes, with sections of rocks and minerals, each with its name attached. From this the visitors passed into the advanced and research laboratories for geology, and thence down the main staircase to the entrance-hall.

PHOTOGRAPHIC STUDY OF STELLAR SPECTRA

Henry Draper Memorial

THE study of stellar spectra by means of photography was one of the most important investigations undertaken by the late Prof. Henry Draper. He was actively engaged in this research during the last years of his life. His plans included an extensive investigation, one object of which was to catalogue and classify the stars by their spectra. Mrs. Henry Draper has made provision, at the Observatory of Harvard College, for continuing these researches, as a memorial to her husband. The results already obtained, with the aid of an appropriation from the Bache Fund, permit the form of the new investigation to be definitely stated. The part of the sky to be surveyed is that extending from the North Pole to the parallel of 30° south declination. Each photograph will be exposed for about one hour, and will include a region 10° square. The telescope employed has an aperture of 20 centimetres (8 inches), and a focal length of 117 centimetres (44 inches). The object-glass is covered by a prism, and the resulting spectrum of each star in the region photographed has a length of about 1 centimetre; which enables the character of the spectra of stars from the fifth to the eighth magnitude to be determined. A modification of the apparatus is employed for the brighter stars.

Meanwhile, experiments are in progress with the 15-inch equatorial, with the object of representing the spectra of some typical stars upon a large scale. The spectra so far obtained are about 6 centimetres in length, and exhibit much well-defined detail. Additional experiments will be tried with a spectroscope provided with a slit, as well as with the simple prism hitherto employed, in order to secure the best possible definition. The present results encourage the expectation that the movements of stars in the line of sight may be better detert mined by the photographic method than by direc observations.

To keep the astronomical public informed of the progress made in this work, specimens of the photographs obtained will be gratuitously distributed from time to time. The first of these distributions will probably be made in a few weeks. Owing to the expense of providing a large number of copies, it is desirable to limit the distribution, as far as possible, to those who are interested in this class of work. It is also desired, however, to send the specimens to all who will find them of value from the scientific point of view. A blank form of request is attached to the present circular, and may be filled out and sent to the Harvard College Observatory by any one desirous of receiving the specimens; but requests to the same effect in any form which may be convenient will also be cheerfully complied with so far as may prove practicable.

EDWARD C. PICKERING,
Director of Harvard College Observatory

Cambridge, U.S., March 20

SOLAR HALO WITH PARHELIA

ON Thursday, April 1, a solar halo with parhelia was seen here, in regard to which, with the consent of the Astronomer-Royal, I beg herewith to offer a few particulars. The best display occurred between 1h. 30m. and 2h. p.m., and at one time exhibited the following appearance. There was the large halo commonly seen, in addition to which a luminous ring passing through the sun encircled the sky, everywhere of the same altitude above the horizon, forming a small circle of the sphere taking the zenith as pole. On this, the parhelic circle, and outside of the halo by about 5°, a mock sun was seen both on the eastern and western sides; another was seen in about a north-north-west direction, and a fourth nearly east, both also situated on the circle.

Calling the real sun S, and the several mock suns, counting westward, S_1, S_2, S_3, S_4, differences of azimuth were independently estimated as follows:—

	S to S_2		S_2 to S_3		S_3 to S
	°		°		°
By myself, numerical estimation ...	115	...	130	...	115
By Mr. Nash, by estimation ...	120	...	120	...	120
By Mr. Lewis, measured from a sketch	123	...	115	...	122
Mean	119	...	122	...	119

apparently indicating that the true difference of azimuth was in each case 120°.

Mr. Turner states that S_4 was on the meridian at 1h. 55m., at which time the calculated azimuth of S from south was 36°, which is therefore the difference of azimuth between S_4 and S. I estimated this difference to be 31°, Mr. Nash 35°, and Mr. Lewis 35°. Mean = 34°. This azimuthal measure corresponds to about 27° as measured on a great circle at about the position of the sun. Deducting 5°, the estimated amount by which S_1 or S_4 was outside the halo, we have 22° for an approximate value of the radius of the halo, about the usual magnitude.

The evidence that the altitude of the circle on which the suns were seen was everywhere the same is as follows:—At 2h. the altitude of the sun, by direct calculation, was 37°. At the same time Mr. Turner, by measurement with the transit-circle, found the altitude of the circle at the point at which it crossed the north meridian to be 37°, it being well seen; its altitude on the south meridian appeared to be 40°, but the circle at this moment was not distinctly visible at this point. At 2h. 15m. Mr. Turner found, with the altazimuth, the altitude of both S_2 and S_3 to be 35°, which, allowing for change of altitude, gives 36½° for the corresponding altitude at 2h.

There were great variations in brilliancy of the different parts during the interval first mentioned, and some of the appearances were visible at a much later hour. The suns S_1 and S_4 at times exhibited prismatic colours in a marked manner.

Two mock suns, such as at times accompany the ordinary halo, were seen also on April 2, and a simple halo also on April 3. WILLIAM ELLIS

Royal Observatory, Greenwich, April 5

NOTES

WE learn that, at the request of the Royal Society, the Treasury has agreed to insert a sum in the estimates, and the Admiralty has agreed to furnish transport and assistance, in aid of an expedition to observe the total eclipse of the sun, visible in the island of Grenada (West Indies) on August 29 next. The Expedition, which will consist of seven observers, will leave England on July 29 in the Royal Mail s.s. *Nile*. According to present arrangements a ship-of-war will meet them at Barbados, and take them on to their various stations. It is a noteworthy sign of the interest taken in such national work by our great public companies that the Directors of the Royal Mail Company have enabled the Eclipse Committee of the Royal Society to increase the number of observers beyond that at first contemplated by a concession in their terms which amounts to an important endowment of the expedition.

MR. H. FOWLER stated in Parliament the other day that the final report of the expeditions to observe the transit of Venus in 1882, subsidised by the British Government to the extent of 14,680*l.*, would be presented in June.

WE have already announced the death, on March 20, at Leyton, Essex, of Mr. Charles George Talmage, F.R.A.S., in the forty-sixth year of his age. Mr. Talmage, who was well known as a skilful astronomical observer, had the entire direction of Mr. J. Gurney Barclay's observatory at Leyton for more than twenty years. During this period he turned his attention chiefly to observations of double stars, and the results of his work are given in four volumes of the "Leyton Astronomical Observations." Previous to his appointment to this post he had served his apprenticeship to astronomy at the Royal Observatory, Greenwich, in the years 1856-60, had worked under Mr. Hind at Mr. Bishop's observatory, first at Regent's Park, and then at Twickenham, and had spent four years at Nice in order the better to prosecute the work on which he was then engaged, the revision of Admiral Smyth's Bedford Catalogue. He was sent to Gibraltar in 1870 to observe the total solar eclipse of that year, and was placed in charge of the Transit of Venus Expedition to Barbadoes in 1882. His death will be much regretted in the astronomical world and by his numerous friends.

MR. EDWARD SOLLY, F.R.S., F.S.A., died on Friday at Camden House, Sutton, Surrey, in his sixty-seventh year. Educated at Berlin, he was appointed chemist to the Royal Asiatic Society in 1838, Lecturer on Chemistry at the Royal Institution in 1841, honorary member of the Royal Agricultural Society in 1842, Fellow of the Royal Society in 1843, Professor of Chemistry in the East India Company's Military College at Addiscombe in 1845, and honorary Professor of Chemistry to the Horticultural Society in 1846. Besides several works in which the importance of chemistry to agriculture was maintained, he wrote "Rural Chemistry" (1843) and "Syllabus of Chemistry" (1849).

MR. RICHARD EDMONDS, the seismologist and antiquary, died recently at Plymouth in his 85th year. He closely studied the extraordinary agitations of the sea and earthquake shocks, and published the results of his investigations in the *Edinburgh New Philosophical Journal*, the British Association *Reports*, and the *Transactions* of the Royal Society of Cornwall. In 1862 Mr. Edmonds published a collection of his papers, under the title of "The Land's End District; its Antiquities, Natural History, Natural Phenomena, and Scenery."

PROF. OLIVER LODGE will give the first of two lectures at the Royal Institution on Saturday next (April 10) on Fuel and Smoke considered with reference to the scientific principles underlying the use of the one and the avoidance of the other. The following arrangements are announced for the Royal Institution lectures after Easter:—Prof. Gamgee, six lectures on the Function of Circulation; Prof. Dewar, three lectures; Prof. A. Macalister, three lectures on Habit as a Factor in Human Morphology; Prof. Ernst Pauer, three lectures on How to Form a Judgment on Musical Works; and Prof. G. G. Stokes, Pres. R.S., three lectures. The first Friday evening discourse will be given by Mr. Frederick Siemens on Dissociation; and succeeding discourses will probably be given by Prof. J. M. Thomson, Sir John Lubbock, Bart., M.P., Prof. O. Lodge, Dr. W. H. Gaskell, and Prof. Dewar.

THE seventh International Oriental Congress will be held at Vienna on September 27 next and following days.

AS the work of unpacking the cases which arrive daily at South Kensington from the British colonies all over the world proceeds, the extraordinary variety and interest of the exhibits become more apparent. In addition to objects of specially scientific interest already referred to, we may mention the ethnological groups in the south or Imperial Court of the Indian section. These are intended to illustrate the physiognomy, dress, and customs of the various races inhabiting the Indian Empire. The collection of woods from the Andaman and Nicobar Islands, shown at the Forestry Exhibition at Edinburgh, has been greatly enlarged, especially by specimens of timber of extraordinary size from the Andamans, and will be shown in the Indian section. One of these, the *Diospyros Kurzii*, a marble wood, resembles a combination of oak and ebony. There will be two timber trophies from the Indian Forest Department; one will be a triple arch 46 feet broad by 15 feet high, containing over 300 kinds of wood, while the second will be formed wholly of bamboo, of which thirty species will be shown. The most original arrangement of woods, however, is that adopted in the Victorian Court. Each specimen is in the shape of an octavo volume, on the back being printed, as a title and place of publication, the scientific name of the wood and the locality whence it came. The whole collection is inclosed in a handsome book-case, and so resembles a small library. Prof. McCoy and Baron von Müller have prepared a large natural history collection, and one of rare plants from Victoria in albums. The entomological collection is said to be remarkably complete, upwards of a thousand distinct specimens of insects being included. The Melbourne Botanical Gardens send a collection of fibres and carpological specimens. In a natural history case in the Canadian section, prepared by Col. Stockwell, will be a general representation of the fauna and flora of Anticosti. New Guinea has been taken under the wing of Queensland, and collections from that island will be explained by Mr. Hugh Romilly, who will be appointed Assistant Commissioner for Queensland specially on this account. The trophies in the various sections will also be of great interest and beauty; Ceylon will have a natural history trophy, India a jungle trophy, Queensland two of natural history—one being animals, the other birds—and so for other courts. It may be hoped that one result of this Exhibition and of the meeting of colonists from all quarters of the globe simultaneously in London will be the establishment of a permanent colonial museum in London. The Exhibition will supply abundant materials with which to make a beginning.

IN commemoration of the fiftieth year of the foundation of the Museum of Native Antiquities at Kiel, the directress, Fraülein Mestorf, has published a hand-book on the prehistoric antiquities of Schleswig-Holstein, containing 62 plates with 765 pictures of typical prehistoric objects, the originals of which are for the most part in the Kiel Museum. The first 17 plates contain 149 objects of the Stone Age, vessels, flint, horn, and bone implements, and pottery, some of which is decorated; the second section is composed of 18 plates containing 227 objects from the Bronze Age, swords, knives, saws, urns, &c.; lastly, there are 27 plates with 399 objects belonging to the Iron Age, which began in Schleswig-Holstein in the first or second century immediately preceding our era. The last representatives of this series are some silver *denarii* of Charlemagne's time. On the whole the collection appears to be a remarkably complete one for a single province to produce and preserve.

THE third volume of the *Transactions* of the Washington Anthropological Society (November 1883—May 1885) contains a suggestive paper by the President, J. W. Powell, on the growth of barbarism and civilisation from the savage state. This paper, which formed the subject of the annual address delivered on February 3, 1885, deals with the successive stages of savagery, barbarism, and civilisation from a somewhat novel standpoint. It is argued that the evolution of culture, that is, the gradual development of mankind from savagery to civilisation, is essentially the evolution of the humanities—the five great classes of activities denominated arts, institutions, languages, opinions, and intellections. Hence if the course of culture is to be divided into stages, the several stages should be represented in every one of the classes of activities. If there are three stages of culture, there should be three stages of arts, of institutions, and so on. Here the author deals more especially with the essential characteristics of the first two stages, defining the epoch of transition, and explaining how the lower phases of the various activities are developed into the higher. The evolution has everywhere proceeded on the same lines, because the human race is fundamentally one in the strictly genetic sense. The tendency to depart from the original type would doubtless have resulted in the establishment of specific differences, as in the case of other organisms, had it not been checked by various causes arresting free biotic evolution, and bringing about a return to homogeneity. For although much diversity exists it is restricted to narrow limits, the essential characteristics being everywhere the same. Again, after a certain stage is reached, human evolution differs radically from that of all other organisms. It proceeds, not by survival of the fittest, or adaptation of the species to the environment, but on the contrary by adaptation of the environment to the species. There is no aquatic variety of man, no aërial, tropical, boreal, herbivorous, or carnivorous varieties; but man has everywhere adapted the environment to himself, that is, created an artificial environment by his arts, and in general by the development of his inventive and other intellectual faculties. Man has inherited the body, instincts, and passions of the brute; the nature thus inherited has survived in his constitution, and is exhibited along all the course of his history. But man has risen in culture not by reason of his brutal nature; he has been evolved because he has been largely emancipated from the laws of the brute creation. His development has been through the development of the humanities, that is, of those qualities which distinguish him from the brute. It has been a mental and moral far more than an animal evolution. Hence the curious result that, while the mind of man differs immeasurably from that of the next highest in the scale of animal evolution, his body is on the contrary in some respects actually inferior, physically weaker, less able of itself alone to struggle with the adverse conditions of the environment.

THE thirteenth meeting of Scandinavian Naturalists will take place at Christiania between July 7 and 12.

ON the 11th of last month, at about 6.15 p.m., a meteorite fell on the ice off Aastvedt, in the province of Bergen, Norway, with the effect of making a hole about 18 inches in diameter, though the ice was 8 inches in thickness. It was accompanied by an audible hissing.

THE great success of the oyster cultivation carried on by the Norge Company in the Christiania fjörd has induced the Swedish Government to invite the manager of this establishment to inspect the coast of the province of Bohus, on the opposite side of the fjörd, with a view to the arranging of similar establishments there should the conditions be favourable. A gunboat has been placed at the disposal of the inspector by the Government. The subject is engaging much attention in Sweden, where very few oyster-banks exist.

ON the night of March 30, between 8 and 9 o'clock p.m., there was a very fair display of auroric light in the co. Donegal. Mr G. H. Kinahan writes:—" At the time the sky to the northward was clear and bright, but after 9 p.m. it became overcast, with dark snow-clouds. The light was peculiar for Ireland, not being of the usual type, but bright light silver-coloured, of the type seen in the autumn in Canada, although far less elaborate. The light extended from the N.W. to the N.E. To the N.E. was a wide column of white light, rather stationary, but at times extending across the zenith in a broad arch to the N.W. horizon. Between this column and the N.N.W. point, being more numerous and prevalent between the N.N.E. and N. points, were pencils and horns of light, even shooting up and down, with clouds of very bright light rising at intervals, and as they ro e sent up pencils of light from the upper edges. In the space between the N.E. and N.N.W. points, the pencils of light rose, some perpendicularly, and some obliquely, in a north-easterly direction. Towards the end of the display dull light-reddish clouds rose at intervals, at one time there being a faint marginal edge to the N.E. white column." During the last winter auroræ appear to have been remarkably scarce, for although on the look-out for them all Mr. Kinahan saw were very faint and scarcely perceptible to any one but those who had studied them.

THE American Government have forwarded a consignment of landlocked salmon ova to the National Fish Culture Association, which arrived this week in excellent condition. A large number of this species were reared by the Association last year, and placed in nurseries pending their introduction to the Thames, where it is felt they will thrive well in certain places. The Thames Angling Preservation Society are particularly anxious to naturalise this species in the river, it being an excellent fish from a sporting point of view, and, moreover, it does not migrate to the sea.

THE German Fisheries Union intend to try the acclimatisation of the sterlet in the Vistula and the Oder. About 2000 living sterlets are to be caught in the Save, under the personal superintendence of Prof. Spiridion Brusina, the Director of the Zoological Museum of Agram. They are to be sent to Thorn and to Oderberg respectively for transfer into the two rivers named above. Hitherto sterlets could only be obtained from Russia.

MESSRS. MACMILLAN AND CO. will publish in a few weeks an elementary treatise on Statics, by John Greaves, M.A., Fellow of Christ's College, Cambridge. Although adapted for those beginners whose mathematical reading does not go beyond geometrical conics and trigonometry, the book contains propositions of a more general character, especially in connection with the principle of work, than any other book that does not assume a much wider range of knowledge on the part of the reader. In order to meet the wants of students who can get little assistance in their work, a large number of illustrative examples have been carefully worked out. The mode of treatment chiefly differs from that usually adopted in that the principle of transmissibility of force is discarded; while the conditions of equilibrium of all bodies, including liquids and flexible strings, are deduced from those of a single particle by means of D'Alembert's principle. The Newtonian definition of force is, of course, the one employed.

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin Monkey (*Cebus albifrons*) from South America, presented by Mr. Matthews; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Miss Agnes Shouman; a Common Kingfisher (*Alcedo ispida*), British, presented by Mr. Cuthbert Johnson; two Cambayan Turtle Doves (*Turtur senegalensis*) from Egypt, presented by M. J. M. Cornély, C.M.Z.S.; a Chinese Mynah (*Acridotheres cristatellus*) from China, presented by Mr. T. Douglas Murray, F.Z.S.; a Huanaco (*Lama huanacos*) from Bolivia, two Llamas (*Lama peruana*) from Peru, a Dingo (*Canis dingo*), a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, two Sonnerat's Jungle Fowl (*Gallus sonnerati*) from Southern India, seventeen Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, deposited; two White-eared Scops Owls (*Scops leucotis*) from West Africa, a Red and Black Lizard (*Ctenosaura erythromelas*), purchased; two Geoffroy's Doves (*Peristera geoffroui*) from Brazil, two Blood-breasted Pigeons (*Phlogœnas cruentata*) from the Philippine Islands, received in exchange; a Black Lemur (*Lemur macaco*), an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

AN ASTRONOMICAL DIRECTORY.—M. Lancaster, of the Brussels Observatory, has compiled and published a most useful list of observatories, with their geographical co-ordinates and the astronomers attached to them, of astronomical societies and institutions, and of reviews and journals specially devoted to astronomy. The pamphlet also contains a select list of the names and addresses of those astronomers who are not attached to any observatory, and of amateurs, as well as a further list of makers of astronomical instruments. As is practically inevitable in a work of this nature, there are faults both of omission and of commission noticeable in it. The most conspicuous of the former perhaps occurs in the account of the English *Nautical Almanac* office, where the staff is represented as consisting of the superintendent and *one* assistant. There are, we believe, as many as eleven assistants attached to this office. A good many mistakes have also been made in the addresses of individual astronomers. We hope that in a second edition M. Lancaster will be enabled to remove these blemishes from what must be considered, on the whole, as a very valuable publication, and one which ought to be in the library of every astronomer who is engaged in the active work of his profession.

ROUSDON OBSERVATORY, DEVON.—Mr. Cuthbert Peek has recently published a short *résumé* of his astronomical work during the years 1882-85, including a description of his private observatory near Lyme Regis. This observatory, of which a photograph is given, is solidly built, and seems to be very thoroughly equipped for its size. It contains a transit instrument, by Troughton and Simms, of 2 inches aperture; an equatorial by Merz, mounting by Cooke, of 6·4 inches aperture; solar and sidereal chronometers; position-circle micrometer by Hilger, &c. Beneath the equatorial room is a room used as a laboratory and for photography. Of the observations, the most important is a monograph on the nebula surrounding η Argûs. Mr. Peek had joined the Expedition under the command of Capt. W. G. Morris, R.E., which was sent out to Queensland to observe the transit of Venus in 1882, and, whilst at Jimbour, the place selected as the observing-station, made the observations here recorded. The other observations are of comets 1883 *b* (Pons-Brooks), 1884 II. (Barnard), 1884 *c* (Wolf), Encke's comet, the lunar eclipse of 1884 October 4, occultations of Aldebaran, Saturn, Nova Andromedæ, and the meteor-shower of November 27 last. As the observatory was in course of erection during the years 1884 and 1885, and therefore no systematic work could be undertaken, this record must be considered as very satisfactory.

THE GREAT MELBOURNE TELESCOPE.—The first part of observations of the southern nebulæ made with the great Cassegrain reflector at Melbourne has just been published. Other parts, containing the results of observations for the revision of the southern nebulæ observed by Sir John Herschel at the Cape of Good Hope in the years 1834 to 1838, the work to which the telescope has been chiefly devoted since its erection in 1869, are to follow at short intervals. The present part contains a description of the instrument itself and of the methods employed in using it, together with observations of some of the smaller nebulæ, and it is illustrated by two good photographs representing the great telescope and its surroundings, and by three lithographic plates of the nebulæ observed. The report as to the performance of the great telescope is to the effect that on the average of ordinary fine nights it is somewhat disappointing to one accustomed to observe with smaller apertures, but on *really good nights* it is quite different. So large an aperture, that is to say, requires specially good atmospheric conditions for its full powers to be displayed. The number of nights fit for using the telescope is given as about 40 per cent., but of best nights only 17 per cent. Moonlight nights are reckoned as bad nights, as, though used for lunar photography, they are unsuitable for the special work to which the instrument is devoted—the observation of nebulæ. The observations of the nebulæ given afford several remarkable instances of apparent changes having taken place in a few years. Nebulæ Nos. 187 and 567 ("Gen. Cat.") seem to differ from Herschel's description, and the group of four nebulæ—Nos. 962, 963, 966, and 968—appear to have altered in their relative positions in a very striking manner in the interval between Mr. Turner's observation in 1876·8 and Mr. Baracchi's in 1884·8. It seems very difficult to explain the differences between the descriptions of this group by Herschel, Turner, and Baracchi.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 APRIL 11-17

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 11

Sun rises, 5h. 15m.; souths, 12h. 1m. 1·7s.; sets, 18h. 47m.; decl. on meridian, 8° 24′ N.: Sidereal Time at Sunset, 8h. 6m.

Moon (at First Quarter) rises, 10h. 15m.; souths, 18h. 6m.; sets, 1h. 52m.*; decl. on meridian, 17° 41′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 56	11 43	18 30	8·31 N.
Venus	3 48	9 14	14 40	7 26 S.
Mars	14 9	21 15	4 21*	11 56 N.
Jupiter	16 23	22 37	4 51*	2 2 N.
Saturn	8 41	16 53	1 5*	22 51 N.

* Indicates that the setting is that of the following morning.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
Algol	3 0·8	40 31 N.	Apr. 12,	23 38	*m*
			,, 15,	20 27	*m*
U Monocerotis	7 25·4	9 32 S.	,, 12,		*m*
U Canis Minoris	7 35·2	8 39 N.	,, 12,		*m*
V Cancri	8 15·2	17 39 N.	,, 12,		*M*
R Hydræ	13 23·5	22 42 S.	,, 14,		*m*
δ Libræ	14 54·9	8 4 S.	,, 11,	4 18	*m*
			,, 15,	20 0	*m*
R Coronæ	15 43·9	28 30 N.	,, 17,		*m*
S Scorpii	16 10·9	22 37 S.	,, 15,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 14,	3 52	*m*
		and at intervals of		20 8	
X Sagittarii	17 40·4	27 47 S.	Apr. 14,	2 20	*m*
			,, 17,	0 0	*M*
W Sagittarii	17 57·8	29 35 S.	,, 13,	21 30	*M*
β Lyræ	18 45·9	33 14 N.	,, 13,	19 10	m_2
			,, 17,	0 0	*M*
R Lyræ	18 51·9	43 48 N.	,, 12,		*M*
S Delphini	20 37·8	16 41 N.	,, 13,		*m*
δ Cephei	22 24·9	57 50 N.	,, 14,	21 40	*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Occultations of Stars by the Moon (visible at Greenwich)

April	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image	
			h. m.	h. m.	°	°
13	ξ Leonis	6	20 0	near approach	342	—
14	48 Leonis	6	22 57	23 40	40	329
15	τ Leonis	5	21 21	21 55	359	310
16	13 Virginis	6	18 14	19 4	69	180
16	Uranus	–	21 58	22 44	6	297

April	h.	
16	12	Jupiter in conjunction with and 0° 29′ north of the Moon.

Meteor Showers

Amongst the radiants represented at this season are the following:—Near ψ Ursæ Majoris, R.A. 162°, Decl. 48° N.; from Coma Berenices, R.A. 190°, Decl. 21° N.; from Libra, R.A. 225°, Decl. 5° S.; from Corona, R.A. 240°, Decl. 25° N.; from Hercules, R.A. 265°, Decl. 23° N.; maximum April 13.

GEOGRAPHICAL NOTES

THE sixth German "Geographentag," which will be held at Dresden on the three last days of this month, together with a Geographical Exhibition, will, first of all, bring up the reports of the two travellers, Messrs. Reichard and Lieut. von François, concerning their experiences and observations in Equatorial Africa. Dr. Ed. Naumann will speak on his topographical and geological survey of Japan, and Director A. Matzat, of Weilburg, on drawing in geographical instruction. Further addresses which will be delivered are by Dr. G. Leipold (Dresden), on the raising of the sea-level near the coasts of continents; by Dr. Hahn (Königsberg), on the development and division of coasts from a geographico-commercial point of view; by Dr. P. Lehmann (Berlin), on the significance of Kant for geographical science; by Dr. Egli (Zürich), on the development of the nomenclature of towns, &c.; by Dr. Petri (Berne), on the exploration of Siberia; by Dr. O. Schneider (Dresden), on the closer limitation of geographical terms; and by Dr. S. Ruge (Dresden), on the Central Commission for German topography.

A LETTER was recently read before the Russian Geographical Society on March 17 from M. G. N. Potanin, the leader of another Expedition to Central Asia. At the end of October last the explorer was on his way from Sukhan-Hiln to Lon-djou. He had met great difficulties on this journey; the Expedition having been compelled to march on foot and their luggage to be carried by porters. The direction of the return journey will depend on the success of the proposed passage across the Desert of Gobi. However, this return is secured.

WE have received a communication from M. Grigoriev, Secretary of the Imperial Russian Geographical Society, in which he informs us that Dr. Bunge has left Nasàtchyé, his headquarters, on the Yana River, in command of the Expedition to explore the New Siberian Islands during the summer, and that he is expected back at the end of October or early in November. These islands, which by many Arctic explorers are held to be the right base for an attack on the Pole, are very little known, not having been visited since 1823.

THE Norwegian Storthing has granted a sum of 4500*l.* towards the further geographical survey of Norway.

MR. C. WINNECKE, of South Australia, has prepared a plan showing the contour of the country along the overland telegraph line from Port Augusta to the Queensland boundary, a distance of 1626 miles.

THE SAHARUNPUR BOTANICAL GARDENS

MR. J. F. DUTHIE'S Report on the progress and condition of the Government Botanical Gardens at Saharunpur and Mussoorie for the year ending March 31, 1885, has reached us. It is a bulky Report of some fifty-one pages and a very interesting Report of fifteen pages, on "an examination of the indigenous grasses and other fodder-yielding plants growing on the Hissar Birland," under date September 5, 1885, accompanies it. In the Report on the Gardens, amongst other interesting and important matters Mr. Duthie refers to samples of wheat and barley grown in the Saharunpur Garden, which had attracted some amount of attention in this country. He says:—"Amongst some contributions for the Economic Museum of the Royal Gardens, Kew, which I took to England last year were two samples of grain—one of a variety of wheat called 'Gujaria,' and grown at Saharunpur from selected seed, the original having been received some years since from the Government Farm at Cawnpore; the other a remarkable variety of loose-grained barley, of a dark chocolate colour, from a small sample exhibited at a previous agricultural show at Saharunpur." These samples were considered by the authorities at Kew to be of sufficient interest for their being specially reported on, and they were accordingly sent to Messrs. McDougall Bros., of Millwall Docks, who reported to the effect that the samples had been shown to most of the principal people on the Corn Market, who took much interest in them. The wheat was valued at about 30*s.* per 496 lbs., it being classed with the Kubanca (Russian) wheat, its bright and clean appearance causing much remark. On grinding and pasting it was found to contain much gluten, but to be somewhat sticky. The reporter thinks, however, that it would pay better to grow the white seed, such as is now shipped from Bombay, and realises 39*s.* per 496 lbs. Regarding the barley, the specimen, it is said, was looked upon with much interest, and many opinions expressed upon its being quite new, and the value varied from 23*s.* to 30*s.* per 400 lbs. On damping, the grains were found to sprout well, and so would do for malt, but the colour comes off, and so would not do (it is thought) for pale ales, but it might do well for stout; for feeding purposes it would be useful, although it would take time to remove prejudice against its colour. In some comments on this Report Mr. Duthie says:—"The wheat is a very hard free-growing sort, and always gives a good yield, both in grain and chaff. Last season the yield was 18 maunds and 13 seers chaff per acre. This variety possesses the good quality of being able to stand well up when grown in highly-manured soil; for, as is well known, most varieties of Indian wheat run up into straw and fall over before coming to maturity when the soil is too highly manured. This variety is thus well-adapted for those who attempt to cultivate wheat according to the European method. The chocolate-coloured barley produced 15 maunds grain and 12½ maunds straw per acre. The yield of grain was thus heavier than the yield of straw. The objection as to colour, alluded to in the Report, is fatal to its value, and will prevent its ever being grown except as a curiosity. We possess a white-grained variety of huskless barley, and a good large sample of this has lately been sent to Kew for special report. The huskless barleys appear to be quite unknown in England, and as everything except colour was favourably commented on in the case of the variety sent, I am in hopes that the report on the white variety will be altogether favourable, and perhaps become the means of bringing the barley to the notice of the English market." Mr. Duthie records the introduction of many useful and ornamental plants to the Gardens; and to the Herbarium, he says, large and valued contributions continue to be received, amongst them a very interesting set of specimens from Mr. C. B. Clarke, chiefly belonging to families which have been specially worked up by him in his several monographs contributed to the "Flora of British India" and De Candolle's "Prodromus," also a large collection made by Mr. J. S. Gamble during a tour in the Madras Presidency. Besides which duplicates had been received from Dr. King, of the Calcutta Botanic Garden, and Dr. Trimen of the Peradeniya Botanic Garden, Ceylon. In addition to these contributions, specimens had been placed in the Herbarium collected during Mr. Duthie's expedition to North-Eastern Kumaun. This collection, it is stated, "consists of over 1000 species and varieties, including about 25 new to science, one (*Cystopteris montana*) new to India, and upwards of 128 not previously recorded for Kumaun. The north-eastern portion of Kumaun, including the districts of Dárma and Byáno, had not hitherto been explored botanically, and this, of course, accounts for the large number of new records. Amongst these latter are several which had previously been known only from Nepal and Sikkim. Further investigation will, no doubt, confirm my own conclusions as to the greater similarity of the vegetation along the entire length of the Himalayas as you approach the inner and drier ranges." Mr. Duthie's "Appendix VI.," being "Notes on a Botanical Expedition to North-Eastern Kumaun in 1884," will be read with interest by the botanist interested in Indian plants.

THE SUN AND STARS[1]

V.

Metallic Prominences

VERY impressive indeed are the phenomena when we pass to that other class representing prominences no longer of the quiet sort. These are at times observed shooting up almost instantaneously—the exact rate of motion I will state by and by—to enormous heights; and not only are they seen to shoot up into the atmosphere with very great velocity and with every indication of the most violent disturbance, but the alteration in the lines of hydrogen in the spectrum indicates most violent lateral motions. These phenomena unfortunately have been called eruptions, and, as it very often happens, when we get a word like that coined it means more than it is intended to mean by the author of it; and more or less on the strength of this word "eruption," we have theories trying to explain these prominences on the idea that they are ejected, possibly from a volcano—a real solar volcano—at some distance below the photosphere. I think we have no right to call them eruptions at all. In the first place they are not like any volcanic eruption that man has ever seen.

When we get the chromosphere agitated preparatorily to one of these tremendous outbursts—one of these metallic prominences, as they are called—the lines which we see are different from those in the table which I have given. The Italian observers, to whom we are indebted chiefly for our knowledge on this part of the subject, have recorded three lines, which they call the "elementary metallic prominence spectrum." These are—

4943	No Fraunhofer lines corresponding.
5031	,, ,, ,,
5315·9 = 1474	

Although these energetic prominences are eventually very often full of lines of various vapours these three lines always precede them when the action commences. There is one point about this matter to which I must call attention, and that is that of these three lines one—the 1474 line—is not the line with the same name to which I have already drawn your attention, and about which we know absolutely nothing, but it is a line of iron almost coincident with it, which the temperature of the

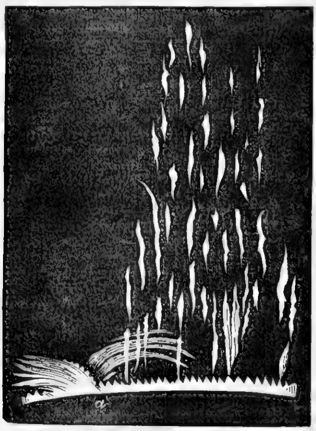


FIG. 15.—Metallic prominence, Young. Rate of ascent 400,000 miles an hour.

spark brings out, though it is invisible in the arc. The other two are lines which do not even appear amongst the Fraunhofer lines at all, and about which, therefore, we know nothing. We have means, both by actual observation in the case of the uprise of the prominences into the solar air and in the change of the wave-lengths of the lines in the case of any lateral motion, of determining how fast these violent prominences rise and are driven by solar winds. Well, these metallic prominences have been seen to mount upwards at the rate of 250 miles a second, that is very nearly 1,000,000 miles an hour; so that, if these gases continued their flight they would reach the top of the solar atmosphere, if the solar atmosphere were 1,000,000 miles deep from the top down to the photosphere, in about an hour's time. There are indications that these prominences, instead of rising vertically, as we may imagine them to do, are at times shot out sideways—almost tangentially. In that case, of course, the spectroscope enables us to determine the velocity. 100 miles a second, either towards or from the eye, is by no means an uncommon velocity, and there are also indications that, in the neighbourhood of the photosphere where these enormous prominences take their rise, vividly incandescent hydrogen at a considerable pressure is rushing up from the interior part of the sun.

In the case of some of these violent prominences the spectrum at the base appears to be full of lines, but we know enough about the subject now to know that many, if indeed not most, of those lines are not Fraunhofer lines at all, not lines with which we are familiar, but new ones. In fact, the same thing happens in the prominences as happens in the spots. To show that this is so I again refer to some very important work done by Prof. Young in the United States some years ago. He went to a station in the Rocky Mountains, at a height of 8000 feet, to observe these prominences. Of course the higher we go the purer the air, and the better we can see. As the result of one month's work he brought back a very valuable catalogue of lines which he had seen in such prominences as I have attempted to describe.

Let us consider one particular substance. It is always well in these matters to be as definite as possible, and if the prominences contained that particular substance, say, for instance, barium, in the same conditions in which we find it on this earth, we should imagine that the spectrum of barium in the prominence would be very much like the spectrum of barium in the electric spark. To see whether that was so or not, what my assistants and myself did was this. We prepared a map showing the lines of barium over a long reach of the spectrum, and we drew the lines so that the longest represented the strongest according to our highest authority in these matters, Prof. Thalèn. Alongside of these we made another map showing the particular lines which had been seen by Prof. Young, and we assumed that the line which was strongest at the sun would be the line which he would most probably see most frequently, and therefore we made the line which he saw the greatest number of times the longest line. That being premised, you will see there is no relation whatever between these two spectra. In the first place a great number of the lines of barium seen in the laboratory are left out of account altogether in the prominence spectrum, and when the other lines are considered we find that the intensities in the sun are quite different; and that, I may say, is a very fair indication of what as a matter of fact we have observed with regard to a number of these substances. Calcium, iron, nickel, cobalt, and several other metals which we have tested in the same way, give us exactly the same result.

But there is more important work to do than that. Since Prof. Young made those admirable observations in America, the Italian observers, Profs. Tacchini and Riccò, have been observing metallic prominences every day. It has been our duty at Kensington to map every line which these industrious Italian gentlemen have observed ever since 1871, and in these maps, as in those of spot-spectra, we have the lines of the various elements seen in the sun, in the arc, and in the spark. Now, of all those lines, we only get a very small number in the prominences. In the case of iron, for instance, in the F—*b* region, we may say there are only two lines; one iron line was left out by mistake by Prof. Thalèn in his map of the solar spectrum, and the Italian observations of the sun suggested to us at Kensington that Thalèn, at Upsala, had made an omission in the spectrum of iron. This we found to be the case. All the other lines are clean swept out of the record. We get none of them in the spectrum of prominences.

At a certain date, I believe about the end of December 1873, the lines in question suddenly ceased to appear in the spectrum of prominences. The Italian observers, who had observed them constantly day by day for three years, suddenly found them gone, but other new lines were seen. I shall show by and by that there was a very good reason why that should have happened. But the important point now is that it really did happen.

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 502.

The Relation between Spots and Prominences

We are now in a position to discuss the relation between the spots and the prominences. We are already familiar with the lines affected in spots. We have now seen the lines affected in prominences. Are they the same? To investigate this question maps have been prepared in exactly the same way as those to which reference has already been made. We have at the top the lines affected in spots, and at the bottom the lines affected in prominences. In hardly any case are the lines of any one vapour widened in the spots the same as the lines brightened in the prominences.

There is another very interesting fact which is also seen alongside of this; if we regard the lines seen widened in the spots, or that other set of lines seen bright in the prominences, we find, when we come to study the positions of those lines in the spectrum with the positions of the lines of elementary bodies, that in the case of very many of them there are coincidences between the lines of different chemical elements with the dispersion that was employed.

We have learnt since then that the coincidence is not entirely absolute, but whether that be so or not, we have the very extraordinary fact that, while of all the iron lines taken at random the chances of the coincidence of any one line are very small, of iron lines widened in spots, or of iron lines brightened in prominences, the chances of coincidence are something like ten to one.

In that way you see we make a considerable difference between the lines of iron which are affected in the lower reaches of the solar atmosphere, whether we are dealing with the phenomena of spots or of prominences, and the lines of iron which are dropped out.

These discussions to which I have referred have led us to make the following statements with regard to prominences, on all fours with the statements already made regarding spots:—

General Statements

(1) The chromospheric and prominence spectrum of any one substance, except in the case of hydrogen, is unlike the ordinary spectrum of the substance. For instance, we get two lines of iron out of 460. Thus we see that the spectrum of a substance in the prominences is very unlike its spectrum out of a prominence, that is, in our laboratories or in a sunspot.

(2) There are inversions of lines of the same elements in the prominences as there are inversions in the spots, that is to say, in certain prominences we see certain lines of a substance without others; in certain other prominences we see the other lines without the first ones.

(3) Very few lines are strongly affected at once, as a rule, and a very small proportion altogether; smaller than in the case of spots.

(4) The prominences are not so subject as spots to sudden changes so far as lines of the same element are concerned.

(5) There is a change in the lines affected according to the sunspot period. This is a point about which I shall have to say something by and by.

(6) The lines of a substance seen in the prominences are those which in our laboratories are observed to be considerably brightened when we change the arc spectrum for the spark spectrum.

(7) None of the lines ordinarily visible in prominences are seen at the temperature of the oxy-hydrogen flame. Some of the oxy-hydrogen flame-lines are seen in the spots, but, as said before, none of these lines have ever been seen in the prominences.

(8) A relatively large number of lines ordinarily seen are of unknown origin.

(9) Many of the lines seen are not ordinarily seen amongst the Fraunhofer lines. Some are bright lines.

(10) As in the spots we found that the H and K lines of calcium in the ultra-violet were always bright in the spot-spectrum, the other lines of calcium being darkened and widened; so also it would appear that the lines H and K of calcium are always bright in the prominences in which the other lines are generally unaffected.

(11) Many of the lines are common to two or more elements with the dispersion which has been employed.

A Case in Point

In the region of the spectrum which has been most studied with regard to spots and prominences, are three lines of iron adjacent in the solar spectrum, so close together, that if you see one you are bound to see the other two. A study of these three lines affords a very definite and interesting case, indicating that it is not at all necessary to go over the whole spectrum to see these results. We have those three lines in the solar spectrum of wave-lengths 4882, 4898, and 4923·1. They are seen among the Fraunhofer lines with the intensity shown in the accompanying diagram (Fig. 16). If we photograph the spectrum of the arc very quickly we miss the right-hand member altogether, and get the two left-hand lines alone. If we observe the spectrum of the iron spark with a quantity coil (and a jar) the left-hand member almost disappears. If we use no jar the right-hand member almost disappears. If we use an intensity coil with a jar not only does the left-hand member nearly disappear, but the right-hand member is enormously developed. If we take out the jar we bring about very much the same condition as we have among the Fraunhofer lines. Now, what happens at the sun? The two lines on the left of the diagram have alone been seen widened in spots. The right-hand member has never been

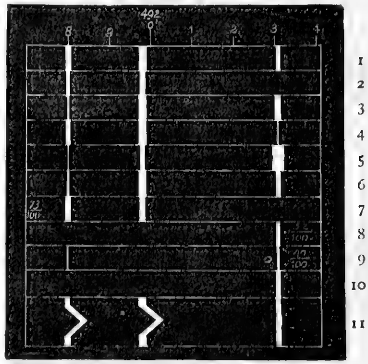


FIG. 16.—Diagram showing the behaviour of three iron lines under different conditions, solar and terrestrial. 1, solar spectrum; 2, arc; 3, quantity coil with jar; 4, quantity coil without jar; 5, intensity coil with jar; 6, intensity coil without jar; 7, spots observed at Kensington; 8, prominences observed by Tacchini; 9, prominences observed by Young; 10, reversed in penumbra of spot observed on August 5, 1872, by Young; 11, motion indicated by change of refrangibility.

seen widened in spots. Contrariwise the right-hand member has been seen in 52 per cent. of the prominences which have been observed by Prof. Tacchini, but the left-hand members have never been seen in any prominence whatever. The last result is this, that in spots the left-hand members have indicated that the spot has been descending at the rate of 50 miles a second, while the right-hand member has shown that the spot is not descending at all—that the vapour is just as quiet as could possibly be expected.

Those are some of the hard facts gathered by the observation of three lines quite close together. During the eclipse of 1882 my chief work was to see what happened to those three lines. What did happen was this: the line seen in prominences was observed 7 minutes before totality began, as a very short bright line close to the photosphere of the sun, whilst the other two lines did not come out until the moment before totality began, and were then very thin and feeble lines at the best, indicating that the absorbing molecules which produce them exist in all probability at a considerable elevation in the sun's atmosphere.

The Corona

We now pass to the inner and outer corona. We are still of course engaged with the question of materials, and may take these two together.

The spectrum of the inner corona indicates that it is chiefly composed of hydrogen. All the hydrogen lines are seen in it, and up to a certain height in it we get the H and K lines of calcium, showing that either calcium, or something that exists in calcium which we cannot get at in our temperature, is there.

When we go further afield into the outer corona we leave behind us most of the hydrogen lines, but one, the green line F, remains for a considerable height side by side with the 1474 line, indicating, as far as we can see where everything is so doubtful, that so far as the gaseous constituents of the outer corona are concerned they consist most probably of hydrogen in a cool form, and this unknown stuff which gives us the line 1474.

With regard to the other materials of the outer corona we know that it contains particles which reflect the ordinary sunlight to us, because in 1871 Dr. Janssen and in 1878 Prof. Barker and others saw the dark Fraunhofer lines in the spectrum of the corona. We must imagine, therefore, that some part of the spectrum of the corona depends for its existence on solid particles which not only give us such a spectrum as the limelight does, but which further have the faculty of reflecting to us the light of the underlying photosphere.

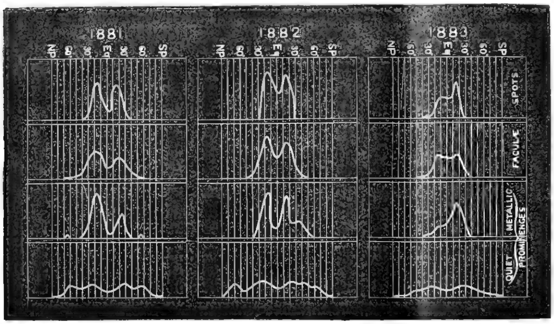


Fig. 17.—Diagram summarising the results of the Italian observations for the years 1881-83.

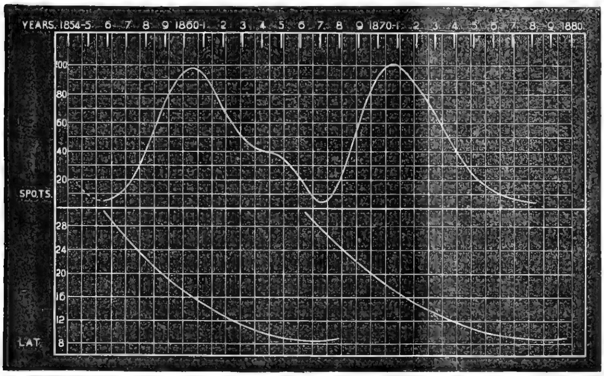


Fig. 18.—Spörer's sunspot curves. The upper one indicates the amount of spotted area in each year; the lower one the mean latitudes of the spots.

It was also put beyond all question in the eclipse of 1882 in Egypt that this corona has another spectrum of its own. I was fortunate enough to see that eclipse under very good conditions, and the spectrum which had been supposed up to that time to be a continuous spectrum only was an integration of a considerable number of spectra. There were bright bands and dark bands from one end of the spectrum to the other, showing that, with these additions, it was no longer continuous in the same way that the spectrum of the limelight is continuous, but that it was probably excessively complex in its origin.

General Connection of the Foregoing Phenomena

We next come to an excessively important point—the connection of the various phenomena which we have now passed under review with each other.

The Italian observers have not only very carefully observed the prominences from day to day, but they have observed spots and the other phenomena which require continuous investigation. The accompanying diagram puts together in a very convenient form much information which we want at the present moment. The information extends over three years, so that we have not merely to depend on the result of one year's observation. The curious-looking hieroglyphics, which are called curves, have a very simple explanation. In the middle of each of these series E stands for the equator, and right and left of that we have vertical lines giving every 10° of latitude from the equator to the poles south or north for each year. The height of the curves from the base-line represents the number either of spots, faculæ, metallic or quiet protuberances seen each year. The spots in the year 1881 had their maximum in latitude 20° N. and 12° S. There were no spots either north or south of latitude 40°, and there were very few spots indeed near the equator of the sun. In 1882 the conditions are a little changed. There are some spots near the equator, and the maximum of spots now is 18° N., and there are more spots this year than there were last, because the curve is higher. Going on to 1883 the maximum of spots has changed from the north of the equator to the south, and in latitude 15° S. we have a reduced maximum, whereas in the northern hemisphere we get very nearly the same quantity in latitudes 10° and 20°. The other curves may now be compared with these, and the point of enormous importance is this, that the maxima faculæ and the metallic prominences agree absolutely in position with those of the spots.

When and where the spots are at the maximum the faculæ and the metallic prominences are at the maximum. If the maximum changes from north to south, as it does, in the spots, it changes from north to south in the metallic prominences, and from north to south in the faculæ; so that were we dependent on these diagrams alone, representing three years' work, we should be driven to the conclusion that there is absolutely the most tremendous and important connection between spots, the metallic prominences, and the faculæ; and not only that, we reach finally the fact of the wonderful localisation of these phenomena upon the sun. The spots are never seen north or south of 40°. They are invariably seen in smaller quantity at the equator; similarly the faculæ do not go very much further than 40° north or south, and their minimum is also at the equator. The metallic prominences also never go very much beyond the spot region, and they also have a minimum at the equator.

But when we pass to the protuberances of the quiet sort that is not so. They extend from one pole of the sun to the other, so that whatever it may lead us to, we are bound to consider that there is the most intimate connection between spots, metallic prominences, and faculæ, and that there is a great difference between the metallic prominences and the quiet ones. That is a result to have arrived at of the very first order of importance.

I have next in connection with that diagram to give another which we owe to the labours of a German observer, Prof. Spörer. Not only have we to accept the fact that these important solar phenomena are limited to certain zones, but we have to study that fact in connection with another, that though all of them vary very violently, they all have what is called a cycle, and the cycle affects the particular zone of the sun on which they appear. Here a sunspot curve, as it is called, writes out for us in a graphic form the quantity of spotted area on the sun from year to year. It begins at 1867, and ends at 1878. This curve means that when the curve is at its highest, we get the greatest number of spots, or the greatest amount of spotted area on the sun's surface. At one place we get a very sudden increase of the spotted area. The curve is almost like a chalk cliff, it goes straight up, but it does not come so straight down. The curve from the minimum of spots on the sun to the maximum is very much steeper than that from the maximum to the next minimum. The sunspot period on an average is one of about eleven years, and it may be said, though I do not want the term to be misunderstood, to represent the seasons on the sun, because when we get that curve low, we see the sun for days together without any spots on it at all. When we get to the highest part, of course there is the greatest number of spots on it.

In connection with that period then, which, as it is good for spots, must also be good for faculæ and for metallic protuberances, after the results obtained by the Italian observers, it is most interesting to see in further detail whether there is any difference in the part of the sun thus affected. The two lower curves show us that when there is the smallest number of spots on the sun—when there is a sunspot minimum—the spots that appear are seen in a high latitude, and that latitude goes on decreasing and decreasing regularly and gradually until we get, at the next minimum, a real over-lapping of two perfectly distinct spotted areas. When we have the maximum period of sunspots, the latitude of the sunspot zone is between 8° and 10°, but it gets much lower than that when the period is closing, and even before one period has closed another one has begun in a higher latitude, so that the swirl in the solar atmosphere seems to begin in a high latitude—say 30° or 35°, or thereabouts—and very soon gets into full swing in latitude between 10° and 12°, and then it very gradually dies away until spots and metallic prominences and faculæ cling pretty near to the equator, and then we get a new wave of activity, beginning again in a high latitude, as is indicated by the beginning of the second curve.

Drawings made by Mr. Carrington a good many years ago show this result in another form, which emphasises the enormous difference in the amount of spotted area, as it is called, at the maximum and minimum time. Another diagram gives the results of the last eleven years' work at Greenwich, where they have been computing the positions of the spots obtained on their photographs and on the photographs which the Solar Physics Committee receives from India. This gives the history of the sunspot period in rather a different way; we begin in the year 1873, and end in the year 1884, and the curves represent the amount of faculæ, of penumbræ, and umbræ. Here again we get both faculæ, penumbræ, and umbræ increasing towards the maximum period, and it is seen that when we come to discuss photographs instead of depending on eye-observations, as the Italians did, we still find that the faculæ and the spots vary together. Another diagram shows another important matter. We are now discussing at Kensington the results obtained from the photographs from several points of view. One point of view is this. It seemed hard, after all the trouble taken to observe latitudes, that all spots north and south of the equator should be lumped together in a mere statement of spotted areas. The two upper curves in the diagram represent the spots north and the spots south; and an important thing which comes out of this is that the curve representing the greatest amount of spotted area north and that representing the greatest amount of spot area north and south do not go together. We do not get the greatest amount of spots north and south of the equator at the same time. A peak in the south curve is in two or three cases associated with a valley in the north curve.

J. NORMAN LOCKYER

(*To be continued.*)

THE CORRELATION OF THE DIFFERENT BRANCHES OF ELEMENTARY MATHEMATICS[1]

AMONG the permanent acquisitions to mathematical science secured within the last half century, within the limits of those branches with which our Association concerns itself, two (I conceive) stand out as pre-eminent in their far-reaching and all-pervading consequences.

These are the firm establishment as distinct entities of two concepts, which have been fixed for all the future of science in the terms *Energy* and *Vector*, and the development of the groups of ideas and principles which cluster around each.

The term *Energy* indeed, and the great principle of the *Conservation*, or (as I prefer with H. Spencer to call it) *Persistence*, of Energy, the establishment of which will live in the history of science as the great achievement of the central part of the nineteenth century, have a scope far beyond the purely mathematical treatment of dynamics and the allied branches of physical sciences. They, the concept and the principle, have already profoundly modified the views of the physicist as to the natural laws with which he is concerned, and are destined to form the starting-point and firm foundation for all his conquests in the future. But no less is it true that the conception of energy, while it has naturally arisen out of the higher mathematical treatment of dynamics, has necessitated a very material recasting of that treatment in its most elementary, as well as in its more advanced, stages, if it is to bear any fruitful relation to physical science in general. This recasting of elementary dynamics, if not yet fully and satisfactorily effected in most of the text-books which still remain in use, in which the notion of energy is brought in rather as the "purple patch" than inwoven into the whole texture of the robe in which the subject is clothed, is yet, thanks pre-eminently to the teaching of Maxwell, Thomson and Tait, and Clifford, in a fair way for being accomplished.

The influence of the conception of energy is, however, as regards mathematics, rather an influence from without than one from within its peculiar domain.

That which is strictly mathematical in the treatment of any science is not its subject-matter, but the *form* in which that subject-matter must from its nature be expressed. Mathematics, as such, is in fact *a formal* (may I not say *the* formal?) science, concerning itself with the particular matter only so far as that matter necessitates a particular form for its expression. Hence the recurrence of the same formulæ and mathematically the same propositions in different branches of science, so that, to take elementary instances, a proposition in geometry may be read off as a proposition in statics by substituting forces for lines, or the formula which determines the speed of the centre of mass of two masses having different speeds is also that which determines the temperature resulting from the mixture of two masses of different temperatures.

To this *formal*, or essentially mathematical, part of the exact sciences belongs the conception of a *Vector*, or rather the group of conceptions which cluster around that term. The term itself was introduced by Hamilton in connection with his grand theory of quaternions about forty years since, but the idea had been already firmly grasped and developed so as to afford a complete explanation of the imaginary ($\sqrt{-1}$) of ordinary algebra within the twenty years preceding that epoch. In fact in the year 1845 I myself enjoyed the privilege, as a young student, of attending lectures of De Morgan on this subject, which he afterwards developed in his treatise on "Double Algebra," published in 1849.[2] I think, however, that we may conveniently date from the introduction of the term "*Vector*," which is now the accepted term for any magnitude which besides numerical quantity or intensity has a definite direction in space, the definitive acquisition of this concept with all its consequences to the settled territory of mathematical science. The calculus of quaternions indeed, or that part of it which was truly original and due to the genius of Hamilton alone, involving the conceptions of the products and quotients of vectors in three-dimensional space, is doubtless beyond the range of what now can be, or within the near future is likely to be, regarded as elementary mathematics; but the notions of vector addition and subtraction

[1] A paper read before the Association for the Improvement of Geometrical Teaching by the President, R. B. Hayward, F.R.S. (see NATURE for January 21, p. 277). We print the address in the hope that a discussion of some of its principles may ensue.

[2] Sir W. R. Hamilton's Lectures on Quaternions were published in 1853.

and their consequences in geometry and mechanics ought assuredly to be considered as within that range, as ought also, for a complete view of ordinary algebra, vector products and quotients in one plane.

If we inquire in what manner we should expect the idea of a Vector and its attendant ideas to affect our elementary teaching, I think the answer would be that it would naturally lead to a different grouping, or arrangement in order, of the various branches taught. It would lead us to group them not according to their subject-matter—arithmetic and algebra, the sciences of number, particular and general; geometry, the science of space; trigonometry, in one aspect treating of space and number in combination, in another as a development of algebra; statics, dealing with forces in equilibrium; dynamics, with forces producing motion; and so on—but according to their *form*, as dependent on the nature of the magnitudes dealt with. One-dimensional magnitudes, that is, magnitudes defined by one element only, whether such as are completely defined by one element, or more complex magnitudes regarded for the moment in respect of one of their elements only, would naturally form the first stage, with subdivisions according as the treatment is purely *quantitative* or *metric*, or *scalar*, that is, metric with the addition of the notion of sign or sense. Then would follow two-dimensional magnitudes, or magnitudes defined by two elements, treated with respect to both elements in subdivisions *metric* and *scalar* as in the first stage, and also finally as complete *Vectors*.

If we further inquire how far these notions have in fact affected our elementary text-books, I think we shall find that the extent to which they have done so is very small. A comparison of the text books of the present day (I speak of them in the gross, not forgetting that there are some important exceptions) with those that were current at the time when my own mathematical studies began, an interval of some forty years, produces the impression of likeness rather than that of contrast. Changes, which are welcome improvements, have doubtless been made in matters of detail, and in various ways the paths have been smoothed for the student; but the general treatment is essentially the same, and shows very little sign of independent thought, informed by more extended views, having been exercised with regard to the old traditional modes of presenting the subject as a whole.

The algebra, for instance, of our ordinary text-books is (if I may venture to give it a nickname which every brother Johnian at any rate will understand) *heptadiabolic*,[1] or that whose highest outcome, in the mind of the pupil who has studied it, is the solution (so called) of a hard equation or equation problem—little more in fact than a series of rules of operation, which skilfully used (and how many fail to attain even this amount of skill) will solve a few puzzles at the end, but very barren of any intellectual result in the way of mental training:—an algebra in which the interpretation of negative results and the use of the negative sign as a sign of affection has been ignored, or so lightly dwelt on, that the notion of the signs + and – as appropriately expressing opposite senses along a line, has to be elaborately explained as almost a new idea in commencing trigonometry; and further, an algebra which, as Prof. Chrystal has observed in his address to the British Association, is useless as an instrument for application to co-ordinate geometry, so that the student has at this stage practically to study the subject again, and only then obtains something of a true notion of what algebra really is.

With the foregoing general considerations as a guide, I will now examine in some detail the correlation or affiliation of the several branches of elementary mathematics to which they seem to lead.

Mathematics naturally begins by treating magnitudes with reference to the single element of quantity. The answers to the simple questions, How many? How much? How much greater? How many times greater? lead up to the arithmetic of abstract and concrete number, and the doctrines of ratio and proportion, and the development of these with the use of the signs +, –, &c., as signs of the elementary operations, and letters to denote numbers or ratios, naturally leads to generalised arithmetic or arithmetical algebra. At this stage $a - b$, where b is greater than a, is an impossible quantity, and a negative quantity has by itself no meaning. In this earliest stage the magnitudes dealt with are either pure numbers or concrete one-dimensional magnitudes, value, time, length, weight, &c., whose measurements are assumed as known. There are few magnitudes which are metric or quantitative *only*, but all magnitudes have quantitative relations which may be regarded apart from their other relations, and so may be the matter or subject of arithmetic, if they are such that their quantity can be estimated definitely or measured. Purely metric magnitudes are such as can be conceived to be reduced in quantity down to zero or annihilated, but of which the negative is inconceivable, so that at zero the process must stop. Such are many magnitudes that are measured by integral numbers—as population, numbers of an army or a flock, a pile of shot, &c., or continuous magnitudes, such as mass, energy, quantity of heat or light, the moisture of the atmosphere, the saltness of water, &c. But there is a far larger class of magnitudes, of which it is true that not only the opposite or negative can be conceived, but that they cannot be fully treated without regard to such opposite. For these, reduction to zero, or annihilation, is only a stage in passing from the magnitude to its opposite, *e.g.* time after and time before a given epoch, lengths forward and backward along a line, receipts and payments, gain and loss, and so forth. The consideration of such magnitudes at once leads to the scalar subdivision of the one-dimensional stage. In this, magnitudes which are themselves purely scalar, or the scalar elements of more complex magnitudes, are alone considered. But to the quantitative element is now superadded the notion of sign or sense, appropriately denoted by the signs + and –, which, without ceasing to be signs of operation, are now regarded also as signs of affection. The introduction of this notion leads at once to scalar algebra, in which $a - b$, where b is greater than a, is no longer an impossible quantity, and a negative result has a definite meaning, so long as the magnitudes dealt with are not purely metric. The step from arithmetical to scalar algebra, though very simple and almost insensibly made, should, I think, be much more distinctly emphasised in our teaching and our text-books than is usually the case. Exercises in metric and scalar readings of the same simple expressions should be frequent, and negative results, whenever they occur, examined and shown to be impossible only if the magnitude in the question is purely metric, but interpretable if it is scalar. Thus the idea would be gradually evolved that the impossibles or imaginaries of algebra are so in a purely relative sense and with regard to the particular subject-matter treated of, and it would become readily conceivable that the remaining impossible quantity $a + b\sqrt{-1}$, to which form scalar algebra, working on the basis of its laws of combination, would show that all expressions may be reduced, may be completely interpretable when ultra-scalar magnitudes form the subject of investigation.

Passing now to the consideration of special magnitudes and how far their discussion can be carried in the one-dimensional stage, I think we shall arrive at some important practical results.

The scalar element of space is length measured forwards or backwards along a line, and the resulting geometry is the simple geometry of points on the same line. Starting from the definition that $-AB$ is BA, the fundamental proposition is that $AB + BC = AC$, whatever be the positions of A, B, C on the line, and this with a few simple consequences completes all that is necessary to be considered in linear geometry.

Combine with this the notion of time, and the science of linear or scalar kinematics emerges This includes the measurement of the motion of a point along a given line by the scalar magnitudes, *speed*[1] and *acceleration*, and the discussion of different kinds of linear motion, uniform and uniformly accelerated, and so the laws of falling bodies. When the notion of a variable rate became firmly grasped, the investigation might be extended to some simple cases of variable acceleration without any large demand on algebraical skill, and so the fundamental notions of the fluxional or differential calculus and some idea of its scope and aim be attained.

Introduce now the notions of force and mass and the axioms of force or motion as contained in Newton's laws, and the science of linear or scalar dynamics results. If we drop for an

[1] The allusion is to a paper which used to be set at the annual May Examinations at St. John's College, Cambridge, consisting of seven very hard equations and equation problems, familiarly known as the "seven devils." As a test of a certain kind of skill in algebraical operation and of ingenuity and clearheadedness it was not without considerable value, but it tended to produce false notions of algebra in its relations to mathematics generally.

[1] The term *speed* has been happily appropriated for the scalar element of velocity. A corresponding term is wanted for the scalar element of acceleration; no better word than *quickening* suggests itself to me.

instant the notion of time, or rather of *change in time*, we have linear statics, which consists of little more than the single proposition—the "tug-of-war" proposition—that the resultant of any number of forces along the same line is their scalar sum. Linear kinetics, however, covers a wide field—the relations of force, mass, and acceleration, their measures and their applications to simple cases of linear motion; the time integral of force, momentum; the space integral, work; energy, kinetic and potential; the relations of force applied to resistance overcome in simple machines working steadily; impulsive actions in collisions and explosions; and other simple developments—would here be studied in their simplest forms apart from any greater mathematical difficulties than arithmetic and very rudimentary algebra, and yet involving almost every truly dynamical principle needed for the highest problems in dynamics. Here, with perhaps a few applications to other branches of physics, the range of the one-dimensional stage ends.

Proceeding next to two-dimensional magnitudes, we commence of course with elementary plane geometry, in which the propositions, which are not purely descriptive, deal with the magnitudes considered in purely metric relations.

The introduction of the notion of sense for lines and angles, denoted by the signs + and −, leads in one direction to elementary trigonometry, and in another to co-ordinate geometry.

Kinematics is now extended to motion in two dimensions, and this should lead at once to the notion of velocity, acceleration, &c., as vector magnitudes, and with this the general notion of a vector and vector addition. In dynamics force emerges as a vector, and the composition of forces regarded as the addition of vectors lays the foundation of statics, or the relations of forces independent of the element of time, to be developed on the one side with the aid of pure geometry and graphical methods, on the other by the application of trigonometry. This is naturally succeeded by uniplanar kinetics, developed more or less fully till it extends to regions beyond the range of elementary mathematics. Algebra will have been carried on *pari passu* to meet the increasing requirements of the special subjects, but will still remain scalar with its impossible or uninterpreted symbols.

The next step is to complete the algebra of vectors in one plane. The notion of a vector and vector addition will already have been grasped and will need only some further application and development, but the extension of the notion of multiplication to vectors in one plane at once leads to the already familiar algebra, but with wider meaning and without impossible quantities or uninterpretable symbols. The immediate result is a complete trigonometry, of which De Moivre's theorem, now completely intelligible and not a mere formula, forms the basis, and the higher developments of ordinary elementary algebra. It will then appear that ordinary algebra receives its full explanation in vectors limited to one plane, and it will naturally be anticipated that the algebra of vectors in any directions in three-dimensional space will be different from the ordinary algebra, an expectation which will be amply justified by the study of the algebra or calculus of quaternions, the grand discovery of Sir W. R. Hamilton, but to pass on to this would be to pass beyond the limits of what is, in the sense of our Association, elementary mathematics.

If the correlation of the elementary branches of mathematics, which I have now sketched out, is accepted as based on true principles, I cannot doubt but that it will lead to important practical consequences, the development of which I may safely leave in the hands of those who so accept it. There are, however, a few immediate deductions from it, which occur to me as naturally calling for expression before I close this paper.

In the first place I would observe that while I believe the several stages in the foregoing scheme to be natural and such as every teacher would do well to have in his own mind in arranging the course of instruction for his pupils, I do not at all regard it as marking out the exact order to be followed by each individual student. There is room here, still in subordination to the general scheme, for wide variation according to the different requirements of different students. It would in almost all cases, I think, be very unwise that any one of the stages should be completed before the next was commenced. For instance, though the theory of ratio is purely one-dimensional and metric, no one, I suppose, would think of dealing with it otherwise than in the incomplete form sufficient for arithmetic before commencing the study of the simple two-dimensional geometry of Euclid or our own text-book. And again, how far scalar or linear kinematics and dynamics should be studied (or whether at all) before proceeding further in the two-dimensional stage to trigonometry, &c., is a question which may fairly be answered in different ways according to the different objects aimed at in the study of mathematics by different classes of students.

It appears to me too to follow from our scheme that, whatever may be true for the select few who aim at becoming mathematicians, for the great mass of those with whom the chief object is, or ought to be, intellectual training, algebra should be studied at first, not as a subject for its own sake, but as an instrument for use in other subjects. I hold that, unless pursued into its higher developments, algebra *per se* is not a valuable instrument of mental training. Can it be said that such algebra as is required (say) at the Previous Examination at Cambridge, a large part of which has had no application for the student in any other subject, is of any value at all proportional to the time it has taken him to acquire it? I think, then, that algebra should be studied piecemeal: first just that small quantity which is necessary for one-dimensional magnitudes treated as scalars; then, when the need was felt from the occurrence of problems requiring more knowledge of algebra, adding more, and so on continually, keeping up the study of algebra concurrently with, and only slightly in advance of, the requirements of the subjects to which it is applied.

Again, our scheme suggests, I think, a definite answer to the question:—What minimum of mathematics is it reasonable to expect every educated man, not professing to be a mathematician, to have acquired?

I think there are few who are satisfied with the answer practically given to this question by our Universities in their first examinations for matriculation or degrees. At Cambridge, the question with reference to the "Little Go" Examination is even now under consideration. I would submit that the subjects included within our one-dimensional scalar stage together with elementary geometry, and statics, treated geometrically, or by graphical methods only, from the two-dimensional, would constitute a far more satisfactory minimum than the present. This would exclude a good deal of the algebra now expected and the trigonometry, but would add linear kinematics and kinetics. The student, who had gone through such a course, would not probably be able to effect any but the simpler algebraical reductions or solve any but the simplest kinds of equations; but he would have gained some notion of what an algebraical formula means as the expression of a law, and be able to deduce from it numerical consequences and to follow out the simpler general results obtainable from it, and he would have acquired a clearer conception and higher appreciation than is common with people otherwise well educated of the part which mathematics plays in its application to the physical sciences, and with it that sound dynamical basis which is the essential condition of a fruitful study of physics. I feel sure, too, that the consciousness of the student that he was dealing with actual living laws and not with the dry bones of algebraical processes or trigonometrical formulæ leading to no results, and that his mathematical studies were meant to be, and were, more than a mere mental gymnastic, would add life and interest to those studies which would react on the whole of his mental training.

I may note, further, that our scheme seems to give the best answer to the question which has frequently been mooted of late, in our Association as well as elsewhere, whether statics should precede kinetics, or whether it should be treated as a particular case of the more general science. Linear kinematics and kinetics, being one-dimensional and scalar, may well precede the study of statics, which deals with vectors, though not of necessity in the case of one who has attained sufficient knowledge of elementary geometry not to be stopped by mere geometrical difficulties; but vector or uniplanar kinetics, on account of its much greater complexity and its consequent larger demands on mathematical attainments, would in general naturally follow a somewhat detailed study of statics.

I will take this opportunity of making one other remark, which, if it does not directly arise out of the present discussion, is closely akin to it, and that is on the importance of our teaching of the several branches of mathematics being *proleptic*, or looking forward in one stage to what will be required in a higher stage. In definitions for instance, of two that are equally good for the immediate purpose, that one is to be preferred which will be intelligible and useful when the term defined comes to be extended to higher matter.

Thus I conceive that multiplication should be defined from the outset in such a manner as would make it applicable to a fractional as well as to an integral multiplier. If I explain that to multiply 6 by 5 is to repeat 6 five times and find the aggregate result, my explanation fails when I am asked to multiply 6 by $\frac{3}{4}$; but if I use De Morgan's definition that "multiplication consists in doing with the multiplicand what is done with the unit to form the multiplier," or an explanation of multiplication cast in this form, I have given an explanation equally simple with the former and applicable also to a fractional multiplier.

Again, in the very beginning of arithmetic, which is counting, I maintain that much would be gained if from the first the child were taught to count, not one, two, &c., but *nought, nothing*, or *zero*, one, two, three, &c.; and then if, later on, ordinal reckoning were made to accord with this, though here unfortunately language and usage fails to supply the word wanted, for which, for want of a better, I must coin the form *zeroth* (*noughtth* or *nothingth* being out of the question), thus: *zeroth*, first, second, &c. Then the transition to counting below zero by negative numbers would follow at once as by a natural development, when the need for it arose. Thus when it came to the notation of numbers, the place of a digit would properly be reckoned from the units as the *zeroth* place (not the *first*), and would be extended naturally by negative ordinal reckoning downwards, when decimal fractions are introduced.

This leads me to another illustration, which I am also anxious to introduce as a suggestion on its own merits. Prof. Chrystal has complained that to many students even when beginning coordinate geometry the idea of the *order* of a term or an expression is unfamiliar. Now it has occurred to me that this is just the word wanted, to replace the five-syllable word "characteristic," which has been used (or perhaps has *not* been used just because it is pentasyllabic) to express the distance of any digit of a number in order from the unit's digit. Let us speak of the unit's digit as of the order 0; the tens, hundreds, &c., digits of the orders 1, 2, &c.; and the tenths, hundredths, &c., of the orders -1, -2, &c.; and add to this that a number is said to be of the same *order* as that of its highest significant digit, and we have a language not only of the utmost use and importance in decimal arithmetic, but also at once applicable by the most natural extension to an algebraical expression arranged according to the powers of some letter or letters, while it would enable us conveniently to express in language numbers which transcend our ordinary numerical vocabulary, so that, for instance, 53×10^{12} might be read as 53 of the 12th order, and 53×10^{-12} as 53 of the -12th order, and so on.

In conclusion I will only add that, if in this paper I have in any parts expressed myself somewhat dogmatically, I have done so in the hope of challenging discussion, and only claim the acceptance of the views which I have tried to express *distinctly*, if *briefly*, in the event of discussion resulting in a verdict in their favour.

ON THE METHOD OF STATING RESULTS OF WATER ANALYSES

THE Chemical Society of Washington is desirous of bringing before chemists and others interested, the report of Committee herewith inclosed; and as NATURE has a wide circulation in this country, I am authorised to send a copy of the abstract to your journal, hoping you may find space for it.

A. C. PEALE, M.D.,
Sec. Chem. Soc. Washington
(Office of U.S. Geol. Survey)

Washington, D.C., February 25

The Chemical Society of Washington, at the meeting of November 12, 1885, appointed a Committee to consider the present state of water analysis, and to present a method of stating analyses, adapted for general use, in order that those hereafter published may be readily compared with each other and with future work. This Committee reported February 11, 1886, and was authorised to prepare an abstract for publication, in order to call the attention of chemists to the subject. The Society earnestly recommends the adoption of the scheme which is herewith briefly presented. The full text of the report will be published in the next *Bulletin* of the Society.

(*Abstract*)

Water analyses are usually made to answer one of three questions, viz:—

(1) Is the water useful medicinally?
(2) Is it injurious to health? and
(3) Is it suitable for manufacturing purposes?

Many books relating to water were published during the eighteenth century, but accurate chemical analysis was not attempted until about 1820. As the earlier analyses were isolated, rare, and made for special purposes, the form of the statement was of little importance if it were only intelligible. At the present time, however, water-analyses are very numerous. An examination of about a thousand shows some forty-two methods of stating quantitative results, there being sometimes three different ratios in the report of one analysis. Such discrepancies render comparisons difficult and laborious. The various methods of statement may be classified under the following general forms:—

(1) Grains per imperial gallon of 10 lbs. or 70,000 grains.
(2) Grains per U.S. or wine gallon of 58,372+ grains.
(3) Decimally, as parts per 100, 1000, 100,000, or 1,000,000.
(4) As so many grammes or milligrammes per litre.

The last two would be identical if all waters had the same density; but as the densities of sea water, mineral waters, &c., are much above that of pure water, it is plain that the third and fourth modes are not comparable. The Committee therefore unanimously recommends—

(1) That water-analyses be uniformly reported according to the decimal system, in parts per million or milligrames per kilogramme, with the temperature stated, and that Clark's scale of degrees of hardness and all other systems be abandoned.

(2) That all analyses be stated in terms of the radicals found.

(3) That the constituent radicals be arranged in the order of the usual electro chemical series, the positive radicals first.

(4) That the combination deemed most probable by the chemist should be stated in symbols, as well as by name.

The abandonment of Clark's *scale* has been recommended by Wanklyn and Chapman; and the recommendation made by the Committee does not involve the disuse of his method, but merely the bringing it into accord with the decimal system—the changing from grains per gallon to milligrammes per kilogramme.

The last conclusion (4) was deemed desirable from the frequent confusion in the statement of the iron salts and of the carbon oxides.

The Committee is unanimously of the opinion that analyses in the form recommended will prove quite as acceptable to Boards of Health and to the public in general, for whom such analyses are often made, as if presented in the mixed and irregular forms commonly adopted.

The Committee also feels sure that the people in general are better able to form a definite idea of the character of a water from a report stated in parts per 100, parts per 1,000,000, &c., than from one expressed as grains per gallon, the latter being a ratio wholly unfamiliar to any but those in the medical or pharmaceutical professions.

(Signed) A. C. PEALE, M.D.
WM. H. SEAMAN, M.D.
CHAS. H. WHITE, M.D.

ON SOME POINTS IN THE PHYLOGENY OF THE TUNICATA

IN his monograph on the genus *Doliolum*, forming one of the recent parts of the series illustrating the Fauna and Flora of the Bay of Naples,[1] Dr. B. Uljanin gives a sketch of the phylogeny of the Tunicata, some parts of which cannot, I think, be accepted without considerable modification. Uljanin has evidently regarded the subject from the *Doliolum* point of view, and, in fact, he only introduces the other groups of Tunicata for the purpose of discussing their relationships to *Doliolum*. Consequently it is not to be wondered at that he should assign rather too central a position to that genus, and give it too much importance relatively to the other groups. What is of more importance is that his scheme shows a course of evolution which seems not altogether in accordance with

[1] "Fauna und Flora des Golfes von Neapel." X. Monographie: Doliolum, von Dr. Basilius Uljanin. (Leipzig, 1884.)

what is known of the anatomy and embryology of the various forms.

In the first place the diagram given on page 123 shows the lines of development of certain groups passing through other existing groups, an arrangement which should be avoided in phylogenetic tables. It always suggests that the groups passed through are the direct ancestors of the group at the free end of the line, and it is highly improbable that any existing forms are precisely the same as the ancestors from which a group was derived. To take an example, Uljanin represents the line of evolution of *Doliolum denticulatum* passing through first *Anchinia rubra*, and then *D. mülleri*, thus suggesting, I hold, that the two last-named species are extinct forms which were direct ancestors of *D. denticulatum*. Now of course *A. rubra* and *D. mülleri* are not extinct, and although they are undoubtedly closely related to ancestral forms on the line of development terminating in *D. denticulatum*, still it is very unlikely that they are in all respects identical with these ancestral forms. The best way to represent such a case diagrammatically would be to place *A. rubra* and *D. mülleri* on the ends of short side branches springing from the main stem at the points which the ancestral forms they seem to resemble probably occupied. In that way the line of evolution of *D. denticulatum* would be shown as passing not *through*, but *close to*, *A. rubra* and *D. mülleri*.

Uljanin represents the Appendiculariidæ giving rise to the Ascidiæ Simplices, from which three lines then diverge, one leading to *Salpa*, the second to the Doliolidæ through *Anchinia*, and the third to the Ascidiæ Compositæ. From this last group (presumably only the typical Compound Ascidians) three lines start upwards, leading,—the first to *Pyrosoma* through *Distaplia* (?), the second to *Botryllus*, and the third to the "Social" Ascidians through *Pseudodidemnum* and *Tridideninum*.

The starting-point in this scheme of evolution is undoubtedly correct. The various existing groups of Tunicata are all descended from common ancestral forms closely resembling the Appendiculariidæ. But the origin of the Salpidæ and the Doliolidæ from groups of the Simple Ascidians is very questionable. The passage from *Appendicularia mossi*[1] through *Anchinia rubra* to *Doliolum*, and through the ancestral Doliolidæ to *Salpa*, seems so simple and natural that it makes it very unlikely that the Thaliacea were ever fixed Simple Ascidians which have undergone great modification and have become free-swimming pelagic organisms again. The argument made use of by Uljanin that the Thaliacea, &c., have not such a typical method of development as the Simple Ascidians, and are therefore a younger group, is not necessarily of great value, since the process of development may have undergone modification.

Then, again, it seems more probable that the Simple and the Compound Ascidians were derived from a common ancestor resembling the simpler forms of the two groups (*e.g. Ciona* and *Diazona*) than that the Compound were derived from the Simple. Many of the Simple Ascidians show far more differentiation and far more specialisation of certain important organs (*e.g.* the branchial sac in the Molgulidæ) than is found in any of the Compound Ascidians.

I must protest against Uljanin's statement that the "Social" Ascidians are a group derived from the Compound forms and having no close connection with the Simple Ascidians. This view is opposed to all we know as to the very close relationship[2] between the Clavelinidæ and the Ascidiidæ. There can, I think, be no doubt, after the examination of such a series of forms as *Diazona*, *Clavelina*, *Ecteinascidia*, and *Ciona*, that the "Social" Ascidians (Clavelinidæ) are intermediate between the least modified forms of the Simple Ascidians (*e.g. Ciona*) and the least modified forms of the Compound Ascidians (*e.g. Diazona*), and ought therefore to be regarded as being closely allied to the ancestral forms from which both Simple and Compound Ascidians were derived.

I agree with Dr. Uljanin in considering *Pyrosoma* a modified Compound Ascidian, but I differ from him inasmuch as I regard it as being derived from the family Didemnidæ, and not from *Distaplia*. The remarkable new genus *Cælocormus*, found during the *Challenger* Expedition,[3] is a valuable connecting-link between *Pyrosoma* and the primitive Didemnidæ, which in their turn were derived from the primitive Distomidæ, thus carrying the origin of *Pyrosoma* back to the typical Compound Ascidians.

Distaplia, which figures in Uljanin's scheme as the stepping-stone to *Pyrosoma*, is not really such an extraordinary form as has been supposed. It is an ordinary Compound Ascidian belonging to the family Distomidæ. The Didemnidæ (*e.g. Tridideminum*) and the Diplosomidæ (*e.g. Pseudodidemnum*) are not at all closely related to the "Social" Ascidians. They are highly modified and in some respects degenerate Compound Ascidians which have probably originated from the primitive Distomidæ.

Dr. Uljanin is, I think, right in regarding the Botryllidæ as an abnormal group of Compound Ascidians worthy of being placed in a branch by themselves. They show certain resemblances to some of the Simple Ascidians, and it is just a question whether they should not be regarded as a remarkably modified offshoot from the primitive Cynthiidæ quite distinct from the other Compound Ascidians. I am inclined to regard the Compound Ascidians as polyphyletic. There is some evidence in favour of their having arisen as three distinct groups from the ancestral Social and Simple Ascidians, and in that case one of these groups would be the Botryllidæ. This question will be discussed more in detail in a paper I am now preparing on the Phylogeny of the Tunicata

On some points, then, I am quite in accord with Dr. Uljanin, while we differ on others. With the modifications suggested above I would accept his views. Probably the most valuable part of his scheme is that dealing with the evolution of the Doliolidæ, and the relations between the different forms of *Doliolum* and *Anchinia*. W. A. HERDMAN

[1] I have ventured to call by this name a species described as new, but not named, by Dr. Moss (*Trans. Linn. Soc. Lond.*, vol. xxvii. p. 229, 1871).

[2] See Herdman, "Report upon *Challenger* Tunicata," part i., and Sluiter, "Ueber einige einfachen Ascidien," &c., *Natuurkundig Tijdschrift v. Nederlandsch-Indie*, Band xlv. p. 160, 1885.

[3] See "Report upon *Challenger* Tunicata," part ii.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science for February 1886 contains:—On the development of the mole (*Talpa europæa*); the ovarian ovum and segmentation of the ovum, by Walter Heape, M.A. (plate 11). Of the two membranes the outer (zona radiata) was thick, the inner (vitelline) thin; between them there was a space; radial canals exist in the outer membrane; no micropyle was observed. Two kinds of yolk are noticed—homogeneous vesicular and minute highly refractive bodies. During maturation the vitellus divided into a medullary and cortical portion, and withdrew from the vitelline membrane, excepting where connected by pseudopodia-like processes, and at the spot where the polar bodies are formed. A single spermatozoon appears to effect impregnation. Segmentation occurs while the ovum traverses the Fallopian tube.—On the development of the Cape species of Peripatus, by Adam Sedgwick, M.A., part 2 (plates 12–14). This part is chiefly devoted to a consideration of the segmentation of the ovum and the formation of the layers. The important and in several cases novel facts brought to notice do not readily admit of being abstracted. The embryo at the gastrula stage and in all the earlier stages of development is a syncytium: no part of the nucleus or centre of force of the unsegmented ovum enters the clear endoderm masses. The gastrula gut arises from an enlargement and confluence of the vacuoles in the centre of the mass.—Studies on earthworms, by W. B. Benham, B.Sc. (plates 15, 16, 16 *bis*). In this series of papers the authors describe a number of earthworms from various parts of the world, placed at his disposal by Prof. Lankester; these include new genera and species. In this paper, after an historical *résumé*, a notice of the hitherto known genera and species is given, and *Microchæta rappi*, Bedd., is described and figured.—The official refutation of Dr. Robert Koch's theory of cholera and commas.

The Journal of the Royal Microscopical Society for February 1886 contains:—Fresh-water algæ (including chlorophyllaceous Protophyta) of the English Lake District, with descriptions of twelve new species, by A. W. Bennett, F.L.S. (plates 1 and 2). A record of a six weeks' collecting in the district between Windermere and Langdale, and no doubt only an indication of what a more protracted study would do for the Lake flora.—Explanatory notes on a series of slides presented to the Society, illustrating the action of a diamond in ruling lines upon glass, by Prof. W. A. Rogers.—On the preparation of sections of pumice-stone and other vesicular rocks, by Dr. H. J. Johnston-Lavis.—On the cultivation of Bacteria, by Dr. E. M. Crookshank (plates 3–5).—On the appearance which some micro-organisms present under different conditions—as exemplified in the microbe of chicken-cholera, by G. F. Dowdeswell, M.A.

(plate 6).—On "central" light in resolution, by J. W. Stephenson, F.L.S.—With the usual summary of current researches and the proceedings of the Society.

The Journal of Physiology, vol. vii., No. 1, January 1886, contains but one memoir, but that an important one by Dr. W. H. Gaskell, on the structure, distribution, and function of the nerves which innervate the visceral and vascular systems (plates 1–4). If the various nerves of different function which are described as innervating the viscera have a real and separate existence, then, as in the case of the motor nerves of ordinary skeletal muscles, a similar correlation must exist between their function and their morphological arrangement. In a series of papers the author proposes to deal with this question for all the different groups of nerves, classifying them according to function, and including afferent as well as efferent nerves. In the present memoir he confines himself to the efferent nerves of the vascular and visceral muscles, treating of the structure and distribution of these nerves; of the nature of the action of the motor and inhibitory nerves of the same, and he further treats of the morphology of the superior cervical ganglion; on the central origin of the ramus visceralis; on the relation of the posterior root ganglia to the visceral nerves; and on the roots of the cranial nerves.

The American Journal of Science, February.—The story of Biela's comet, a lecture delivered at the Sheffield Scientific School of Yale College on March 9, 1874, by A. Newton. This paper is here reproduced in consequence of the renewed interest created in Biela's comet by the meteoric display of November 27, 1885.—Relation between direct and counter-electromotive forces represented by an hyperbola, by H. S. Carhart. In discussing the relations between the electromotive force (E.M.F.) of the generator, the counter E.M.F. resulting from the electro-magnetic reactions taking place in the motor, and the rate at which energy is absorbed by the latter in the electrical transmission of power, it is implicitly assumed that E is constant. Here it is shown that, with an assumed amount of work spent upon the motor per second and a given resistance R, E has a minimum value equal to twice E; this corresponds with Jacobi's law of maximum rate of working or greatest electrical activity and constant E.M.F.—Tendril movements in *Cucurbita maxima* and *C. Pepo* (continued), by D. P. Penhallow. From 436 distinct observations upon the motion of the tendrils and terminal bud under all conditions of temperature, sun and humidity, a normal rate of movement under all conditions to which the plant is ordinarily subjected, has been determined at 0·351 m. per minute. In the terminal bud the greatest movement occurred about noon under conditions of great humidity, the least at night, also during great humidity. In all the results so far obtained we have still further proof of the influence of meteorological conditions on the growth of the plant.—A theorem of maximum dissipativity, by George F. Becker. The proposition here demonstrated is that in all moving systems there is a constant tendency to motions of shorter period, and that, if there is a sufficient difference between the periods compared, this tendency is always a maximum. Hence all natural phenomena occur in such a way as to convert the greatest possible quantity of the energy of sensible motion into heat, or the greatest possible quantity of heat into light, &c., in a given time, provided that the interval of time considered exceeds a certain fraction of the period of the most rapidly moving particles of the system.—A new law of thermo-chemistry, by George F. Becker. Considering chemical energy as a form of motion, and accepting Berthelot's thermo-chemical law of maximum expenditure, the author seeks to ascertain whether any definite results may be reached as to the rate of evolution of heat. The principle arrived at is set forth in the previous paper, the chemical interpretation of which is thus summed up: the sum of the chemical and physical transformations in any chemically active system will be such as to convert higher forms of energy into heat, light, &c., at the greatest possible rate, provided that the interval of time for which the comparison is made is a multiple of a certain fraction of the period of the most rapidly moving particles of the system. This is practically equivalent to the statement that the transformation will be such as to evolve heat, light, &c., at the highest possible rate.—Recent explorations in the Wappinger Valley limestone of Dutchess County, New York, by William B. Dwight. This paper, the fifth contribution on the subject, deals with the discovery of fossiliferous Potsdam strata in the Poughkeepsie district, New York.—Wind-action in Maine, by George H. Stone. Drifting sands, partly of marine, partly of fresh-water deposition, are common in Maine. But here two less common phases of wind-action are considered,—till-burrowing, such as is frequently observed in Colorado, and sand-carving, as seen in the grooves, scratches, and striated polished surfaces of the boulders scattered over several square miles, and already described in Hitchcock's Report on the Geology of Maine (1861).—The westward extension of rocks of Lower Helderberg age in New York, by S. G. Williams. It is shown that the Lower Helderberg period, including all above the Water-lime group, is represented at least as far west as Cayuga Lake by limestones not less than 65 feet thick, containing an unmistakable Lower Helderberg fauna.—Meteoric iron from Jenny's Creek, Wayne County, West Virginia, by George F. Kunz. This specimen, picked up in 1883, is octahedral, belonging to the "grobe Lamellen" of Brezina's new classification, and yielding on analysis: iron, 91·56; phosphorus, 0·13; nickel and cobalt, 8·31;—specific gravity, 7·344.

The American Naturalist for February 1886 contains:—On the post-mortem imbibition of poisons, by Dr. George B. Miller. Treats of a subject of a highly interesting character from its medico-legal aspect.—Notes of an ascent of the volcano of Popocatapetl, by A. S. Packard (woodcuts). The ascent was made from Amecameca (a town forty miles by rail from Mexico, and 8223 feet above the sea) at 1 p.m.; a rancho where the party stopped for the night was reached at 5.40, twelve hours after the ascent proper began; it was for two hours on horseback, and then on foot for three hours and a half. While it was hard work, there were no dangers or difficulties. No notes of the vegetation are given.—Notes on the Œcodomas or leaf-cutting ants of Trinidad, by C. Brest (woodcuts).—The Flood-Rock explosion, by W. H. Ballou.

March 1886:—On the migrations of Siouan tribes, by Rev. J. Owen Dorsey.—The torture of the fish-hawk, by J. Lancaster.—A study of garden lettuce, by Dr. E. L. Sturtevant.—Aquatic respiration in soft-shelled turtles, by Simon H. and Susanne Phelps Gage.—This is a very valuable contribution to the physiology of respiration in vertebrates. By comparing the free gases found in water with those in the same water after a turtle had been immersed in it without access to air, it was found that a turtle, weighing two pounds, in ten hours removed from the water 71 milligrammes of free oxygen and added to it 318 milligrammes of carbon dioxide.—On a new sub-species of the common Eastern Chipmunk (*Sciurus striatus*), by Dr. C. H. Munair.—Fish remains and tracks in the Triassic rocks at Weehawken, N.J., by O. T. Mason.

Journal of the Russian Chemical and Physical Society, vol. xviii. fasc. i.—On the influence of contact on the course of chemical transformations, by Prof. D. G. Mendeléeff.—On the specific gravity of aqueous and alcoholic solutions of mercuric chloride, by J. Schreder.—Thermic data for the group of aromatic compounds, by Werner. The thermic effects accompanying the neutralisation and dissolution of di- and tri-oxybenzoic acids and di- and tri-phenols are determined and verified.—On the action of the tri-carbonate of potassium on salts of nickel and cobalt, by F. P. Rosenblatt. This reaction is proposed as a new method of separation of the above metals and of their qualitative determination also.—On the action of sulphuric acid on oleic acid, by M. Sabaneyeff. Important for dyeing industry; the literature on the subject is given.—On azocumol, by Pospekoff; and on one of the xylidines, by E. Wroblewski.—On the heating of the glass of condensators in consequence of the alternative electrisation, by M. J. Borhman. The author comes to the conclusion that the heating of the glass in consequence of the rapid successive charges and discharges is very nearly proportional to the square of difference of potentials of the charges.—On the demonstration of the second Kirchhoff's theorem concerning the ramification of electric currents, by J. Borhman.—On the geometrical demonstration of the conditions of minimum declination of a ray in the prism, by V. Lermontoff.

Bulletins de la Société d'Anthropologie de Paris, tome viii., fasc. 3.—Sequel to M. Verrier's paper on the various modes of delivery practised among the women of civilised and savage nations.—Report of M. Hovelacque's address at the third meeting of the Transformist Conference, on the evolution of language. This treatise cannot be commended on the score of originality or profoundness of knowledge, or even as contributing in any way to the advance of philology.—Hypothetical suggestions as to the origin of right-handedness or left-handedness, by M. Dareste. The author believes that we must seek in embryonic relations for the preponderance of the right hand over the left, in which he sees a possible result of the position generally maintained by the fœtus in regard to the vitellus, in which one side of the body enjoys greater freedom for development than the opposite one. Dr. Dareste wishes to verify, by the observation of others, his hypothesis that left-handedness is present in those who suffer from inversion of the viscera (heterotaxy), which would seem to be unquestionably due to malposition in the fœtal state.—M. Sebillot has presented to the Society a comprehensive formula of questions relating to the appearance, character, and various other phenomena of the sea, together with the popular legends and superstitions connected with it by different races. These he wishes to see incorporated with the Society's authorised directions for travellers.—Note on May celebrations in the Gironde, by M. Daleau.—Discussion on the assumed Quaternary jaw found at Châlons-sur-Marne, and forming part of M. Nicaise's collection. M. Topinard, who gave the result of his own measurements, considers that the differences between this jaw and the one found at Naulette prove the co-existence, in primæval ages, of different human types. The Naulette jaw he regards as unique of its kind, differing as it does from the thousand and upwards of inferior maxillæ which he had examined with special reference to this question. — On the difficulties of distinguishing between genuine prehistoric trepanning and recently effected injuries of the crania, either through accident in the process of exhumation, or for purposes of deception, by M. Manouvrier.—On the best means of measuring the cranial capacity, by M. de Jouvenrel.—On Broca's method of determining cranial cubage, as exemplified by means of a bronze test-cranium, by M. Topinard.—On an archæological exploration on the Island of Téviec, near Quiberon, by M. Gaillard. The similarity of the dolmens, shells, and bones with those on the neighbouring mainland, and the numbers and character of the silex and bone fragments found on the island, lead the writer to believe that a separation from the continent has been effected since prehistoric ages.—On the Dutch dwarf known as Princess Pauline, by M. Mortillet.—On curious methods of conducting barter in parts of Asia and Africa, by M. Hovelacque. In tracing the history of the development of the process of bartering silently and from a distance, which still prevails between tribes or castes who refuse to meet or be seen by each other, the author draws attention to notices by Herodotus which prove the existence of the same customs among the people of Libya.—On the existence of wars in primæval times, by Dr. Hoffman, of Washington.—On the finds of a cave near Ojcow, by M. Zaborowski. Numerous fragments of the bones of the mammoth, rhinoceros, hyæna, and cave-bear were found intermixed with those of the ox, horse, hare, &c., together with flint knives, bone implements, &c.—On the brain of an insane woman, by M. Rey.—On a case of microcephalism, by M. Letourneau.—On a gibbon-fœtus and its placenta, by M. Deniker.—On ideas and memory, by M. Fauville. In this elaborate treatise the author considers memory as the result of special manifestations of the impressionability of the sensient cellules of the brain, while ideas are defined as the consequences of sensations.—On the common origin of Malays and Dravidians, by M. O. Beauregard. In this sequel to his former paper on the subject of the Malayan races the author begins with their language, which may be traced from the Moluccas as far west as Easter Island, many words in use among the inhabitants of the various island-groups that lie between these remote limits being absolutely the same. This paper is an exhaustive compendium of what has been written by other authors, chiefly Englishmen, on the language and legendary literature, the political and social constitution, and the religion and laws of the Malayan and Dravidian races, with special reference to those settled in Ceylon.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 11.—"The Electrical Phenomena accompanying the Process of Secretion in the Salivary Glands of the Dog and Cat." By W. Maddock Bayliss, B.Sc., and J. Rose Bradford, B.Sc., Senior Demonstrator of Anatomy in University College, London (from the Physiological Laboratory of University College). Communicated by E. A. Schäfer, F.R.S.

March 11.—"The Influence of Stress and Strain on the Physical Properties of Matter. Part I. Elasticity (continued). The Internal Friction of Metals." By Herbert Tomlinson, B.A. Communicated by Prof. W. Grylls Adams, M.A., F.R.S.

An abstract of a paper on this subject has been already published (*Proc. Roy. Soc.*, vol. xxxviii. p. 42), but the paper itself was withdrawn for the purpose of revision. The fresh experiments which have been for this purpose instituted during the last year, besides confirming the results of the older ones, as far as the latter have been published, have furnished, more or less in addition, the following facts relating to the internal molecular friction of metals:—

The proportionate diminution of amplitude is independent of the amplitude, provided the deformations produced do not exceed a certain limit. This limit varies with the nature of the metal, and is for nickel very low.

The logarithmic decrement of amplitude increases with the length of the vibration-period, but in a less proportion than the latter, and in a diminishing ratio. The amount of increase of the logarithmic decrement, attending on a given increase through a given range of the vibration-period, varies with the nature of the metal, and with those metals which possess comparatively small internal friction becomes almost insensible. It follows as a consequence that the internal friction of metals differs from the viscosity of fluids, for in cases of damping by the latter the logarithmic decrement is *inversely* as the length of the vibration-period.

Permanent molecular strain resulting from loading not carried to a sufficient extent to produce sensible permanent extension, diminishes the internal friction, and increases the torsional elasticity.

Considerable permanent longitudinal extension and permanent torsion produce increase of internal friction and diminution of torsional elasticity. The effect of torsion is much greater than that of extension, and the increase of internal friction is much greater than the decrease of torsional elasticity. As a consequence, wire-drawing, where we have permanent extension and torsion combined, sometimes increases enormously the internal friction; in fact, in the case of six different metals it was found that, by careful annealing, the internal friction was decreased from *one-half to one-thirtieth* of the original amount of friction of the metals in the hard-drawn condition.

The internal friction of a metal wire, whether in the hard-drawn or annealed condition, is temporarily decreased, and the torsional elasticity is temporarily increased by loading not carried beyond a certain limit; beyond this limit both the friction and the elasticity become independent of the load.

The "fatigue of elasticity," discovered by Sir William Thomson in metal wires when vibrating torsionally, is not felt, provided the deformations produced do not exceed a certain limit, depending upon the nature of the metal. The above-mentioned limit is extraordinarily low for nickel, so low, indeed, that it is difficult to avoid "elastic fatigue" with this metal. This last consideration, and others founded on the results of experiments on the effects of stress on the physical properties of nickel, tend to show that the molecules of this metal are comparatively easily rotated about their axes.

The author agrees with Prof. G. Wiedemann, that the loss of energy due to internal friction in a torsionally vibrating wire is mainly due to the to-and-fro rotation of the molecules about their axes; any cause, therefore, which increases the molecular rotatory elasticity diminishes the internal friction, and conversely.

The molecules of a metal tend to creep into such positions as will ensure a maximum molecular rotatory elasticity, and they can be assisted in doing so by agitations effected either by thermal or mechanical agency; hence—

Rest after suspension, aided by oscillations at intervals, diminishes the internal friction of a wire which has been recently suspended, or which after a long suspension has been subjected to considerable molecular agitation by either mechanical or thermal agency.

On the contrary, when a maximum molecular rotatory elasticity has been reached, molecular agitation, if carried beyond a certain limit, diminishes the elasticity; hence the results of "fatigue of elasticity;" and hence—

Mechanical shocks and rapid fluctuations of temperature beyond certain limits may considerably increase the internal friction, and, though to a much less extent, diminish the torsional elasticity.

The logarithmic decrement is independent of both the length and diameter of the wire.

"Effects of Stress and Magnetisation on the Thermo-electric Quality of Iron." By Prof. J. A. Ewing, B.Sc., F.R.S.E., University College, Dundee. Communicated by Sir William Thomson, F.R.S.

This paper comprises a revised version of one submitted to the Royal Society in 1881, under the title "Effects of Stress on the Thermo-electric Quality of Metals, Part I." (published in abstract in *Proc. Roy. Soc.*, No. 214, 1881), along with much new matter. It deals principally with the cyclic changes of thermo-electric quality which an iron wire undergoes when exposed to cyclic variations of stress (described in the abstract of the former paper), and with the relations of these changes of thermo-electric quality to the changes of magnetism which also occur as an effect of stress. Stress was applied by exposing the wire to longitudinal pull by means of loads. The changes both of thermo-electric quality and of magnetism exhibit that tendency to lag behind the changes of stress to which in a previous paper (*Proc. Roy. Soc.*, No. 216, 1881, p. 22) the author gave the name ***hysteresis***, and the effects are sufficiently similar in regard to the two qualities to suggest that the changes of thermo-electric quality occur as secondary effects of changes of magnetism. To examine whether this is the case, simultaneous measurements of the magnetic and thermo-electric effects of stress on an iron wire were made, and also independent observations of the thermo-electric effects of magnetisation, without change of stress. A comparison of these made it clear that stress causes change in the thermo-electric quality of iron directly, and not as a secondary effect of magnetisation. If the wire be completely demagnetised to begin with, and kept clear of all magnetisation during the application and removal of stress, the presence of hysteresis is not less marked than before. Experiments are given to show how the thermo-electric effects of stress are modified by the existence of more or less magnetisation in the wire; and, conversely, how the thermo-electric effects of magnetism are modified by the existence of more or less constant stress. The influence of vibration in destroying the effects of hysteresis is investigated, and also the result of exposing the wire to the process of demagnetising by repeated rapid reversals of a continuously diminishing magnetising force, and it is shown that this process acts in the same way as vibration in destroying the effects of hysteresis. Residual effects of hysteresis are studied, as, for example, the difference which presents itself when a wire is magnetised after having been loaded strongly and then unloaded down to a certain constant state of stress, and, on the other hand, when the same state of stress has been produced by simply increasing the load; and it is shown that these residual effects are wiped out by vibration or by demagnetising by reversals. With regard to the effects of stress on thermo-electric quality it is shown that if a somewhat soft wire be more and more strongly magnetised these effects become more and more similar to those which are found when the wire is hard-drawn but not magnetised. A few experiments were made with wires of silver, copper, lead, magnesium, aud German silver, but in none of these was hysteresis of thermo-electric quality with regard to load discovered.

Special attention is directed to a peculiar feature in the curves by means of which the experimental results are exhibited. In curves showing the relation of thermo-electric electromotive force to load, it is shown that any reversal from loading to unloading, and *vice versâ*, causes an inflection in the curve, the first effect of the new process being to continue the kind of change of thermo-electric quality that was going on before. That this is not due to any mechanical disturbance which the loading or unloading produces is shown by the fact that it occurs in an equally marked way after the molecules have been brought to a condition of stable equilibrium by vibrating the wire before beginning to load or unload. It is suggested that the effects of hysteresis, described in the paper, have a possible relation to the properties which Prof. Osborne Reynolds has recently shown to be possessed by granular media.

The experiments described in the paper are closely connected with those which were communicated to the Society in January 1885, under the title "Experimental Researches in Magnetism," and are now being published in the *Philosophical Transactions*. They were conducted in the Physical Laboratory of the University of Tokio, in 1881–83, partly with the help of one of the author's Japanese students, Mr. S. Sakai. The results are given graphically, and are for the most part reduced to absolute measure.

March 18.—"On the Properties of Matter in the Gaseous and Liquid States under Various Conditions of Temperature and Pressure." By the late Thomas Andrews, M.D., LL.D., F.R.S. Communicated by the President.

The following are the general conclusions to which this inquiry has led:—

(1) The law of gaseous mixtures, as enunciated by Dalton, is largely deviated from in the case of mixtures of nitrogen and carbonic acid at high pressures, and is probably only strictly true when applied to mixtures of gases in the so-called perfect state.

(2) The critical point of temperature is lowered by admixture with a permanent gas.

(3) When carbonic acid gas and nitrogen diffuse into each other at high pressures, the volume of the mixture is increased.

(4) In a mixture of liquid carbonic acid and nitrogen at temperatures not greatly below the critical point, the liquid surface loses its curvature, and is effaced by the application of pressure alone, while at lower temperatures the nitrogen is absorbed in the ordinary way, and the curvature of the liquid surface is preserved so long as any portion of the gas is visible.

Linnean Society, April 1.—Sir John Lubbock, Bart., President, in the chair.—Mr. J. G. Baker exhibited *Scolopendrium Devalyi*, a new species of fern discovered by the Abbé Devalyi in the province of Yunnan.—Dr. F. Day showed photographs of the fully-grown skulls of *Salmo salar* and *S. fario*, in proof of the marked cranial differences existent in the very adult stages of the salmon and the trout.—A paper was read, botanical observations made in a journey to the Naga Hills (between Assam and Munipore), by Mr. C. B. Clarke. Writing from Kohima, a station 4750 feet altitude, he says the country above 5000 feet is nearly all jungle, and that the predominant plant-groups, such as the Commelinaceæ, Rubi, Senecio, and ferns, besides others, are nearly all identical with those growing in Sikkim, while, on the contrary, many Khasi plants are conspicuously absent. Various kinds of oaks form forests around Kohima, and the alder is abundant, the latter occasionally having an enormous trunk. The Nagas pollard the alder at 6 feet from the ground, and cut the innumerable sprouts for firewood. Two rare species of Dyospyros were observed. The flora is altogether rich and interesting, though there are few new species. Mr. Clarke gives an account of his ascent of Jakpho, a mountain-peak 9980 feet high, and about 10 miles distant from Kohima. *Lomaria glauca*, a rare fern in Khasia, is here plentiful, rhododendrons are plentiful at 8500, and the ridge at the top is clothed with dwarf bamboo. The levels 5000 to 7000 feet on Jakpho are mostly forests of shrubby Strobilanthes 6 to 12 feet high, just as in Sikkim. There are several laurels, and *Ilex Aquifolium* exists as a tree 30 to 40 feet high. The Convolvulaceæ are prominent up to 5000 feet.—The first part of a lengthened technical communication, "Index Floræ Sinensis," or an enumeration of all the plants known from China proper, Formosa, the Corea, and the Luchu Islands, together with their synonymy and distribution, was spoken to by the authors, Messrs. F. B. Forbes and W. B. Hemsley.—Afterwards a paper was read by Mr. H. N. Ridley, on the fresh-water Hydrocharideæ of Africa. Among many new species described is *Boctia exserta*, obtained by Sir John Kirk on the borders of the Zambesi in 1860.—The Secretary read a communication, on the vegetation of the Arctic regions, by M. Buysman. The author remarks that the flora of Greenland is decidedly Scandinavian in character. Almost all the plants are also found in Lapland, but, notwithstanding the proximity of America, few belong to that continent, while Asiatic Arctic types are rare. Some 378 species of phanerogams and cryptogams compose the Greenland flora. Of these, over 200 are found on the eastern coast, only 7 of them being absent on the western shore, while 170 species are recorded from the west, these being absent on the east. Nova Zemlya and the Island of Waigatz together possess 290 species, and Spitzbergen 117 species. The author enters into particulars regarding the special plants peculiar to the seaboard, and such as are cultivated by the inhabitants both in the open air and under cover. He remarks that the long and continuous summer sunlight, and at times intense heat, have much influence on the vegetation, and counterbalance the dark severe winter season.

Geological Society, February 24.—Prof. J. W. Judd, F.R.S., President, in the chair.—William Barns Kinsey and Henry Maurice Platnauer were elected Fellows, and Prof. Juan Vilanova y Piera, the University, Madrid, a Foreign Correspondent of the Society.—The following communications were read:—On two Rhætic sections in Warwickshire, by Rev. P. B. Brodie, M.A., F.G.S. The sections noticed in this paper were (1) one exposed on a railway at Summer Hill, near Binton, between Stratford and Alcester, and (2) one, thirteen miles further to the south-east, at Snitterfield, three miles north of Stratford-on-Avon, in excavations for a tunnel connected with a supply of water to that town. At the first-named locality, a bed with insect remains overlies the firestone and *Estheria*-bed, and this is succeeded in descending order by a considerable thickness of black and grey shales with the usual Rhætic fossils. The bone-bed is not exposed. At the second locality, in borings and shafts, black Rhætic shales were found in three places resting upon a denuded surface of new Red Marl, and covered by between 40 and 50 feet of drift. *Avicula contorta* and other typical fossils were obtained from the shales. In other shafts the Rhætic beds were wanting, so that apparently those met with were merely small portions remaining of a larger mass which had been denuded away.—On the basement-beds of the Inferior Oolite of Gloucestershire, by E Witchell, F.G.S.—On the Pliocene Beds of St. Erth, by Percy F. Kendall and Robert G. Bell, F.G.S. This paper consisted of a description of the beds exposed at St. Erth, a list of the Molluscan fossils identified, and some preliminary considerations of the evidence afforded by the Mollusca, and may be considered a continuation of that by the late Mr. S. V. Wood, read to the Society in November 1884.

Royal Meteorological Society, March 17.—Mr. W. Ellis, F.R.A.S., President, in the chair.—Mr. W. E. Addison, Mr. A. W. Clayden, M.A., F.G.S., Mr. T. B. Moody, R.N., and Dr. W. Schlich were elected Fellows of the Society.—The President gave an historical sketch of the barometer. After remarking on the accidental nature of the discovery of the instrument in the year 1643 in its best form, in ignorance for some time of its value for purposes of meteorological inquiry, he gave a brief account of many early kinds of barometers, the first endeavour being, in consequence of difficulties experienced with the ordinary mercurial form, to enlarge the scale of variation, attempts which in general introduced other errors and inconveniences. The desire to experiment on elevated positions induced the construction of an early form of portable barometer—one such with cistern completely closed, leaving the air to communicate through the pores of the wood, having been made above 200 years ago. The President further described various points in the arrangement of the Ramsden, Gay Lussac, and other barometers, including also mention of some modern patterns of long-range barometers, standard barometers, and such barometers as are more commonly used. The practice of driving out air from the mercury by heating or boiling appears to have been in use early in the last century. Engraved plates indicating the weather to be expected with different heights of the mercury have been longer used, at least as early as 1688. As regards correction for temperature, De Luc in the last century adopted a temperature corresponding to 54°·5 F. as that to which to make reduction, because corresponding nearly to the average of observations, such reduction being now made to the natural zero, 32° F. Reference was made to the employment of water (as in the well-known Royal Society barometer) and other liquids instead of mercury; also to various kinds of floating and other barometers not at all, or not entirely, mercurial, and to metallic barometers. The President concluded his account with a sketch of the history of recording barometers or barographs, including a notice of the application of photography and electricity to recording purposes.—At the conclusion of the President's address the meeting was adjourned to afford the Fellows and their friends an opportunity of inspecting the valuable and interesting exhibition of barometers which was opened on Tuesday evening.

Anthropological Society, March 23.—Mr. Hyde Clarke, Vice-President, in the chair.—Capt. C. R. Conder, R.E., read a paper on the present condition of the native tribes in Bechuanaland. The new Crown colony of Bechuanaland is a pastoral country, consisting of a great plateau 4000 feet above the sea, with a fine climate, and grazing-lands said to be among the finest in South Africa. The native population consists of about 183,000 souls, belonging to various tribes. The Korannas are a small slightly-built people with a strongly Turanian type of face, but with hair growing in isolated tufts as among the Bantu races; they colour the face and hands with red lead, and black lead is often used for colouring the hair. The Matabele are originally Zulus, who, being unsuccessful in war, were afraid to reappear before Chaka: they settled in the Transvaal, and were driven thence to their present country by the Boers. Their name in Sechuana means "naked," and is due, not to the fact that they are lightly clad, but because they offend Bechuana ideas of decency by not wearing the small fur apron which men and boys always wear among the Bechuana, even when they have no clothes. The author described the Batlaping and Baralay tribes, and discussed some of the peculiarities of the Sechuana language. The customs, superstitions, and native government of the people were dwelt upon, and Capt. Conder concluded by referring to some of the causes of the decay of the native tribes, and urged that the chiefs should be supported in their attempts to keep brandy out of their towns.

EDINBURGH

Royal Society, March 15.—Sheriff Forbes Irvine, Vice-President, in the chair.—Prof. Blyth described an apparatus for determining the absolute strength of an electric current by weighing.—Dr. D. Noel Paton gave an account of an experiment concerning the connection between urea formation and bile secretion.—Dr. G. A. Atkinson read a paper on the volumetric estimation of inorganic nitrates.—Dr. Orme Masson read a paper on sulphines—Prof. D'Arcy Thompson submitted a paper on the pelvic girdle of birds and reptiles.

PARIS

Academy of Sciences, March 29.—M. Jurien de la Gravière, President, in the chair.—On the flexion of prisms (continued), by M. H. Resal. In this concluding part of his memoir the author deals with the rectangular prism and the elliptical cylinder. In the special case of flexion here considered, the hypothesis advanced by him from the first on the nullity of three pressures is rejected for the elliptical prism but admitted for the rectangular prism, the problem regarding which in connection with flexion may be considered as solved.—Notes on the progress of the Panama Canal, by M. Ferdinand de Lesseps. The eminent engineer reports favourably of the progress made since his first visit six years ago. There has been great improvement in the sanitary conditions, with corresponding diminution of mortality amongst the workmen. During his inspection a rocky eminence 30 metres high, at Gamboa, about the centre of the isthmus, was successfully disintegrated by the explosion of a mine, two parts dynamite and one part powder, which removed 20,000 cubic metres without accident. With the means at present available, he considers that the canal will be completed, as promised, in 1889.—On the variations in the toxic properties of the urine in the healthy subject while awake and asleep, by M. Ch. Bouchard.—Equatorial observations of Fabry's and Barnard's comets, made at the Observatory of Algiers with the 0·50 m. telescope, by M. Ch. Trépied.—On the best instrumental dispositions for determining the elements of refraction by means of M. Lœwy's method, by Mr. David Gill. Some modifications of M. Lœwy's apparatus are proposed, with a view to simplifying its application, and increasing the general accuracy and usefulness of the method.—On the Fuchsian functions and the indefinite ternary quadratic forms, by M. H. Poincaré.—On an extension of Paschal's theorem to surfaces of the third order, by M. A. Petot.—On the determination of the genus of a holomorphous function in certain special cases, by M. de Sparre.—Note on the surface of the sixth order with six straight lines, by M. Giovanni Bordiga.—Note on the screw-pile, by M. Léauté. M. Resal having worked out the theoretical principle of this useful mechanical appliance, the author proposes a case, not considered by him, which presents the twofold practical advantage of diminishing the friction offered to the action of the screw-pile in borings, and preserving greater cohesion to the surrounding soil. In reply to this communication M. Resal expressed himself unable to adopt M. Léauté's standpoint at least until it has been put to some practical test.—On the theory of dynamo-electric machines acting as receivers (two illustrations), by M. Giza Szarvady.—Description of an absolute electrometer with continuous indications, constructed by MM. E. Bichat and R. Blondlot.—Combinations of vanadic acid with the oxygenated acids, by M. A. Ditte. Here the author deals with those oxygenated acids, such as sulphuric, arsenic, iodic, &c., which may be freely isolated under the form of crystals. Those hitherto obtained only as salts are reserved for future consideration.—On the products of decomposition of hypophosphoric acid, by M. A. Joly.—Action of platina at a red heat on the fluorides of phosphorus, by M. H. Moissan.—On the decomposition by compensation of compound bodies optically inactive, by M. E. Bichat.—On a photo-chemical reaction of the oxymetric fluid of M. Schützenberger, by M. Victor Jodin. It is shown by repeated experiments that the oxymetric reagent is of itself sensitive to light and that account should be taken of this property in researches dealing with photo-chemical reactions accompanied by a liberation of oxygen.—On the volatile character of the oxygenated nitriles, by M. Louis Henry.—Note on the salivary glands in the order of Coleopteræ, by M. J. Gazagnaire. A chief result of the author's researches is the verification of the hypothesis that salivary glands are developed throughout the whole order of Coleopteræ.—On the mode of formation of the chromatophores in the Cephalopods, by M. C. Phisalix.—On the toxic properties of the Cytisus, by M. Ch. Cornevin. Of ten species of Cytisus two were found to be harmless (*C. sessiliflorus* and *C. capitatus*), two slightly venomous (*C. nigricans* and *C. supinus*), six extremely venomous (*C. Laburnum, C. alpinus, C. purpureus, C. Weldenii, C. biflorus*, and *C. elongatus*).—Note on the Palæozoic formations of the Neffiez-Cabrières district, Hérault, by M. de Rouville.

BERLIN

Physical Society, February 5.—Dr. R. von Helmholtz, in an investigation into the tensions of vapour of solutions of salt, made use of a method whereby the least depressions under which a condensation of vapour occurred, when no heat was admitted from the outside, were determined. With this end in view a glass cylinder was filled to a third of its capacity with the fluid. The space filled with a mixture of air and vapour was on one side connected with a manometer, while a second cock allowed the depression to be effected, a small over-pressure having been generated beforehand. The first formation of cloud was rendered visible in this wise, that a bundle of light was directed through the axis of the glass cylinder, and the observer in a dark section of space under small angle looked towards the axis. Experiments with pure water showed that in saturated air the depression needed first to attain a certain value before the formation of cloud set in. Under the temperature of a sitting-room this depression amounted to about 10 mm. water; at 0° a depression of 12 mm. water was required. In this investigation Herr von Helmholtz confirmed the statements of MM. Coulier and Aitken, that the formation of cloud in saturated air was induced solely by particles of dust. Saturated air completely free of dust might suffer a depression of half an atmosphere without any cloud getting formed in it. The finer and sparser were the dust-particles the slower was cloud in forming itself in the vapour-saturated air. Salt-particles and acids furthered the formation of cloud, and, most powerfully of all, particles of sal-ammoniac. An explanation of this phenomenon the speaker found in the proposition demonstrated by Sir William Thomson, that the tension of vapour was greater over convex than over even surfaces of fluidity. When the air was without dust-particles there were wanting the convex surfaces at which the tension was higher and it was possible for the precipitate to ensue. Dust-particles, on the other hand, presented such surfaces, and all the more the rougher they were. In the atmosphere dust-particles must be present as far up as to the highest layers in which clouds were formed, seeing that without them no cloud-formation was possible. This circumstance yielded support to the explanation given by Prof. Tyndall of the blue colour of the sky, in accordance with which the sky was indebted for its blue colour to the particles floating in the air. The dense and persistent fog-formations in large cities, such as London, were caused by the sulphuric acid with which the air was charged in consequence of the vast consumption of coal, and which thus favoured the formation of clouds. The fact, demonstrated by experiments, that saturated water vapour did not, even under the lowest depression, give rise to the formation of cloud, but required first to attain a perceptible magnitude, rendered necessary a change in the theoretical formulæ for the conditions of cloud-formation. Determinations executed according to this method of the tensions of vapour of various sulphuric acid solutions showed a very good agreement with those executed by Regnault.—Dr. Fröhlich gave a short report on the results of his investigations, lasting for years, into the theory of the dynamo-electrical machines, which he had developed with special reference to the practical requirements of technics, and had quite recently published in a separate work. He communicated and explained the concluding formulæ he had found for the performance of the various systems of machines, in respect of their magnetism, as also of their intensity and polar tensions. He likewise gave the formulæ for the performances of the dynamo machines as transmitters of energy. Be it here specially brought out that, in contrast with MM. Deprez and Silvanus Thompson, he had found that, for the mechanical performance of two machines of similar construction and unequal dimensions, the larger did not gain in mechanical labour to the extent of n^5, n being used to denote the linear enlargement, but only in the proportion of about n^3, in which the mass also increased. The utility-effect, on the other hand, of a machine of similar construction, increased with enlargement in the proportion of n^5.

BOOKS RECEIVED

"British Museum (Natural History) Mineral Department—An Introduction to the Study of Meteorites."—"Astronomical Observations 1882–85 made at Rousdon Observatory," by C. E. Peek.—"Arithmetic for Schools," by the Rev. J. B. Lock (Macmillan).—"Sixteenth Annual Report of the Wellington College Natural Science Society, 1885" (Bishop, Wellington).—"Key to the Text-Book on the Mechanics of Materials, &c.," by M. Merriman (Wiley, New York).—"The Elements of Economics," vol. i., by H. D. MacLeod (Longmans).—"Watt's Organic Chemistry," edited by Prof. W. A. Tilden (Churchill).—"Bulletin of the Philosophical Society of Washington," vol. viii. (Washington).—"The Doctrine of Evolution in its Application to Pathology," by Dr. W. Aitken (MacDougall, Glasgow).—"A Manual of Mechanics," by T. M. Goodeve (Longmans).—"The Code of Nomenclature and Check List of North American Birds" (American Ornithologists' Union, New York).

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THURSDAY, APRIL 15, 1886

BIRD-MURDER

A VERY urgent appeal to the public has just been issued in America by our contemporary *Science*, which journal has attached to its issue of February 26 a special "Supplement" devoted to the question of "the present wholesale destruction of bird-life in the United States." Powerful articles have been written by Messrs. J. A. Allen, W. Dutcher, and G. B. Sennett, three prominent American ornithologists, in which the facts have been plainly set forward, remedial legislation proposed, ending with an "appeal to the women of the country on behalf of the birds."

The American Ornithologists' Union has also appointed a "Committee on Bird-Protection," and from the names of the gentlemen who are serving on it, it is quite certain that practical remedies will be forced on the consideration of the American people, and that energetic efforts will be made to preserve the birds from destruction. But it is equally certain that a corresponding effort must be made by civilised nations on this side of the water, if remedial measures are to have a real effect, and we are glad to find that steps are being taken to attract public attention to the gross scandal which now exists in our midst. A "Selborne Society" has been formed, of which Mr. G. A. Musgrave, of 45, Holland Park, is the secretary, and of which H.R.H. Princess Christian is a patron, for the protection of birds. Invoking the shade of the gentle Gilbert White of Selborne, this Society may hope to prevail somewhat with the English nation, which would undoubtedly protest with the same vehemence on behalf of the small songsters of England, as it did some years ago on behalf of the sea-birds, if the facts are but put plainly forward. We are certain that if the women of this country only knew the real state of the case, the senseless and savage decorations now in vogue would be regarded with disgust and loathing. The Selborne Society has but just commenced its labours, but already many excellent well-wishers have joined it, and it numbers amongst its members many names famous in society, in art, in literature, and in science.

There is scarcely a portion of the world which is not being devastated of its birds at the present moment to minister to the fashionable wants of the women of Europe and America, and it is as well that the root of the evil should be recognised at once. This has been done in America, and the point must be insisted on again and again in this country, that the vanity of womankind is in this enlightened age the cause of the "wholesale destruction of bird-life" on this side of the Atlantic as much as in America. Nor is it confined to the higher classes. The difference between the factory-girl and the high-born lady as regards the question of bird-feather decoration is only one of degree, the former paying as many halfpence for the starling's wing in its natural state as the latter does in shillings for the same article dyed or gilt out of recognition as it may be. New Guinea and the Papuan Islands are being despoiled of the birds of paradise, India and Africa of their sun-birds and rollers, Southern Europe of its bee-eaters, until every one of these countries is being exhausted of its feathered denizens. It is no longer the brightly-plumaged species which are being laid under contribution, for, as exhaustion has begun to limit the supply, the soberly-clad birds are now being shot down in thousands to minister to "fashion" in this country. Thus any one with a knowledge of birds has only to walk down any fashionable thoroughfare in London, and note the materials with which the bulk of the hats in the milliners' shops are decorated, to see that robins, sparrows, larks, and starlings are a staple commodity with the trade in this country. Dyed they are in most cases, and occasionally relieved by the wings of some Indian "jay" (*i.e.* roller), or African "merle" (glossy starling) or sun-bird, or it may be with a few "osprey" feathers. These last are the long breeding-plumes of the egrets, which are developed only during the nesting season, and the slaughter amongst these birds at that time of the year must be something incredible. No wonder that Mr. Allen complains that the "swamps and marshes of Florida have been depopulated of their egrets and herons." It is not as if the birds thus slaughtered were harmful, the killing of them beneficial. On the contrary the majority of the species now massacred are distinctly beneficial to the countries they inhabit, and surely no one could wish that this country should be deprived of its birds and reduced to the generally unaviferous aspect of France and Italy.

It is said that legislation in the direction of the further protection of birds would be an interference with the legitimate industry of the "plume" trade. This is by no means the case. There are many birds which are used as articles of food, the plumage of which could be utilised for decorative purposes; and that this is well known by the trade is evidenced by the large number of dyed fowls' wings which figure largely in the composition of hat and bonnet ornament. Just as before, when the outcry against the slaughter of gulls and sea-birds rendered the wearing of their feathers unfashionable, the milliners adapted their wares to the wants of their customers, so would they once more find substitutes for the larks, robins, and other small birds which they now use by the thousand.

Our American brethren have put forward some practical suggestions with regard to a stoppage of the traffic. Mr. Allen shows that in the natural order of things birds have already sufficient enemies to contend against without having the hand of man turned against them too. Vast numbers perish in the eggs, which are the food of many predatory animals, and numbers perish while yet too young to defend themselves against their enemies. To stress of weather also and the trials of migration large quantities of birds succumb, and a severe winter like the last one causes the death of birds of all classes alike. On the top of all these ills which ornithological flesh is heir to, comes a bloodthirsty demand from the women of civilised nations for their small bodies to adorn hats or ball-dresses—in order that our belles may not leave the monopoly of feather ornamentation to savages. Statistics have not been published giving an exact account of the number of birds annually sold in London by auction for the plume trade, but it is well known that the numbers are enormous. Thirty thousand ruby-and-topaz humming-birds are said to have been sold some years ago in the course of an afternoon, and the number of West Indian and Brazilian birds sold by one auction-room in London during the four months ending April 1885, was 404,464, besides 356,389 Indian birds, without counting thousands of Impeyan pheasants, birds of paradise, &c. In Mr. Dutcher's article on the "Destruction of Birds for Millinery Purposes," he quotes from an article in *Forest and Stream*, wherein one dealer, during a three months' trip to South Carolina, prepared no less than 11,000 skins. "A considerable number of the birds were, of course, too much mutilated for preparation, so that the total number of the slain would be much greater than the number given. The person referred to states that he handles, on an average, 30,000 skins per annum, of which the greater part are cut up for millinery purposes." During four months 70,000 birds were supplied to New York dealers from a single village on Long Island, and an enterprising woman from New York contracted with a Paris millinery firm to deliver during this summer 40,000 or more skins of birds at 40 cents apiece. From Cape Cod, one of the haunts of the terns and gulls, 40,000 of the former birds were killed in a single season, so that "at points where, a few years since, these beautiful birds filled the air with their graceful forms and snowy plumage, only a few pairs now remain." The above extracts out of many interesting facts which could be quoted from the articles in *Science*, give some idea of the slaughter which is going on at the present time, and it is to be hoped that some *immediate* steps may be taken to call public attention to this wholesale bird-murder, before the nesting season begins, when most of the mischief is done among the sea-birds, which congregate in large numbers at that time of year.

Space does not permit us to traverse the whole of the ground taken up by our contemporary, whose articles occupy fifteen pages, but we trust that they will be perused by our readers for themselves. Mr. Sennett's essay on the "Destruction of the Eggs of Birds for Food" proves the wanton waste which accompanies the ways of the professional "egger," to say nothing of the cruelty which accompanies the taking of the eggs. The "Relation of Birds to Agriculture" is a well-written article, as is also an essay on "Bird-Laws," the latter containing resolutions which, if adopted by the Legislature, would undoubtedly prove of great service in protecting bird-life on both sides of the water, but no legislation will avail unless the women of America and Europe can be made to understand that they are absolutely responsible for the wholesale destruction of birds which is now going on, to the great benefit of the plume trade and the milliners, but to the everlasting detriment of the world on which we live. We should like to see some authorised body, such as the British Ornithologists' Union, the Selborne Society, or a Committee of the British Association, taking this matter in hand and organising public meetings to bring the true facts of bird-slaughter before the public; and we have every faith in the good sense of English women to secure a stoppage of the trade which exists by their patronage alone, and which is thoroughly antagonistic to the instincts of humanity.

R. BOWDLER SHARPE

MR. GEIKIE'S "CLASS-BOOK OF GEOLOGY"

Class-Book of Geology. By Archibald Geikie, LL.D., F.R.S. (London: Macmillan and Co., 1886.)

"GEOLOGY is essentially a science of observation. The facts with which it deals should, as far as possible, be verified by our own personal examination. We should lose no opportunity of seeing with our own eyes the actual progress of the changes which it investigates, and the proofs which it adduces of similar changes in the far past. To do this will lead us to fields and hills, to the banks of rivers and lakes, and to the shores of the sea. We can hardly take any country walk, indeed, in which with duly observant eye we may not detect either some geological operation in actual progress, or the evidence of one which has now been completed. Having learnt what to look for and how to interpret it when seen, we are as it were gifted with a new sense. Every landscape comes to possess a fresh interest and charm, for we carry about with us everywhere an added power of enjoyment, whether the scenery has been long familiar or presents itself for the first time. I would therefore seek at the outset to impress upon those who propose to read the following pages, that one of the main objects with which this book is written is to foster a habit of observation, and to serve as a guide to what they are themselves to look for, rather than merely to relate what has been seen and determined by others."

In these words, which form the concluding paragraph of the introduction to Mr. Geikie's "Class-Book on Geology," we have the key-note to the whole work, and the promise which they contain is amply redeemed in the pages which follow. Our author has wandered over many lands; he has always carried with him eyes to see, and the habit of using them which he strives so earnestly and so successfully, in this his latest book as in those which have preceded it, to develop in his readers; and out of the stores of his ripe and varied experience he brings, to throw light on his subject, a wealth of illustration which excites the envy, while it commands the admiration, of those who have not enjoyed all the opportunities for varied observation which have fallen to his lot. But even if passing feelings of envy will obtrude themselves as one happy illustration after another, new from this quarter and new from that, finds a fitting place in the narrative, they soon give way to the pleasanter feeling of satisfaction that these opportunities have been placed within the reach of one who knows so well how to use them; not for the advancement of his own knowledge merely, but whose chief pleasure is to distribute with open hand his treasures to all who care to share them, who has the seeing eye to note, the ready pencil to depict, and the facile pen to paint in words all those manifold workings of nature by the study of which geology was snatched from the shadowy realms of guess-work, and based on a firm scientific foundation.

At the very outset geology is looked at in its proper light, not as an amusement for the collector and a means of learning where he will get pretty and curious objects for his cabinet, not as a field where the ingenuity or perversity of the classifying mind may delight itself with grouping natural products as reason or fancy prompts, not in any other of these limited aspects, beyond which it is to be feared the vision of some geologists never reaches; but as a history, the history of the earth during ages long gone by. And as the historian is careful to inform his readers of the sources from which he has drawn his information, what manuscripts he has collated, what monuments he has inspected, what inscriptions he has deciphered, so the book opens with a description of the materials which are available for constructing a history of the earth. First of all we are reminded that "that history is in progress now as really as it has ever been, and that its events are being recorded in the same way and by the same agents as in the far past;" so that "if we would explore its records in the dark backward and abysm of time, we must first make ourselves familiar with the manner in which these records are being written from day to day before our eyes." We are introduced to this study by an account of the manner in which atmospheric agents are bringing about ceaseless decay over the whole of the surface of the globe. The important part played by the freezing of water receives due notice, but it would seem that sufficient stress is not laid on the magnitude of the force generated during this process. That ice "pushes aside the particles between which it is entangled" would hardly prepare one who does not know it for the fact that ice can burst asunder a cast-iron shell. The figure on p. 72, it may be noticed in passing, does not strike us as very happy. We must also take exception to the reasoning on p. 105: so very little is known about the formation of the manganese nodules and coatings of the abysmal depths of the ocean, that it is somewhat risky to assume that it was an exceedingly slow process. Perhaps, too, a little over-confidence is shown in treating of "fissure eruptions"; doubtless some otherwise puzzling facts do receive easy explanation on the hypothesis that such eruptions have taken place, but this is not enough to convert the hypothesis into a certainty.

We next pass to a description of the more important elements, minerals, rocks, and rock-structures of the earth's crust. It is extremely difficult to decide how much or how little chemistry and mineralogy is desirable in an elementary treatise on geology. It is not safe to refer to special works on these subjects, because the majority of readers would not take the trouble to make the reference, and yet the descriptions which the limits of space will allow of are necessarily so curt and meagre as to be of little practical use; if therefore we criticise any portions of Chapters X. and XI. it is not because we are not fully alive to the difficulties of dealing in an elementary fashion with the subjects of which they treat. In the definition of a mineral it should certainly have been stated that minerals, besides having definite chemical composition and definite geometrical form, have also definite physical properties, such as hardness, which are most valuable as means of recognition.

Again, in the description of a crystal, one of the first points to impress on a beginner is that the dimensions of the faces and edges are of no importance, and that the one thing to note is the constancy of the interfacial angles, and this is a simple truth which any one may be got to understand; we wish this had been brought out more clearly. The author has followed the time-honoured custom of giving a brief summary of the six crystallographic systems. We are sadly afraid that the descriptions, though perfectly accurate as far as they go, and the excellent figures by which they are illustrated, take up room which might be more usefully employed, for these few paragraphs will never enable a student to read a crystal unless it be of the simplest character, and they are not full enough to be an introduction to a more detailed study of crystallography. It has always seemed to us that the best plan for an elementary work would be to take one actual crystal—say of orthoclase, with basal and prismatic faces, clinopinacoids, and orthodomes—and, without using any of these technical terms, to explain how the crystallographer arrives at this crystal by grafting, so to speak, certain additional faces on an ideal simple prism; how the shape of that prism can be defined by reference to certain lines and their inclination to one another, which are called axes; how the position of the additional faces are related to these axes—all of which are geometrical truths of the simplest character; and then to say how all crystals, however complicated, can in like manner be referred to certain simple forms of which there are six; and if you want to know how, you must go to a work on crystallography.

The student will then get a real knowledge of one actual crystal, instead of learning by rote descriptions of ideal forms, not one of which he will meet with in nature. We may next note one or two statements which might be usefully amended in a second edition. It is not universally the case that the least fusible mineral crystallises first in a molten rock, as stated on p. 169; it would be well to mention that the rhombohedral crystals of hæmatite (p. 172) are usually so very flat that they look like plates or laminæ; some zeolites (p. 176) contain calcium and barium as well as alkalies; whether alumina replaces the bases or the silica in hornblende (p. 177) is a question on which chemists do not seem to be agreed; under the head of calcite (p. 179) the wording would imply that the difference between nailhead and dogtooth spar consists only in a difference in the length of the chief axis, which is not the case. When it is said that gypsum is not "affected by acids" (p. 206), it is probably meant that it does not effervesce with acids. The evidence for looking upon heat as a pseudomorph after chalk, so to speak, is so strong that it might have been alluded to on p. 212. Under the head of quartzite it would have been desirable to notice that the conversion of sandstone into quartzite has in many cases been mainly brought about by the deposition of silica between the original quartz grains. And while we are on the subject of metamorphism it will be well to call attention to a slight inaccuracy of language into which our author, in common with many other geologists, has fallen. The important part played by pressure in developing schistose structure in rocks is now very generally recognised, and has been nowhere better illustrated than by the labours of Mr. Geikie and his colleagues on the Geological Survey among the crystalline schists of the Highlands, and a fashion has arisen of speaking of the action as "shearing." Now, that shearing has taken place there can be no doubt, but shearing is not all that has happened: the particles have not only been slid over one another, but they have been rolled out and flattened in the process. Shearing does not necessarily involve flattening, though in a large number of cases the two would doubtless go together. For this reason tt is not correct to speak of cleavage as due to "shearing" (p. 255): shearing alone will not produce all the phenomena of cleavage; there must be flattening of the particles as well. Under the head of "Joints," instead of vaguely stating that some joints may be due to compression or torsion, would it not have been better to introduce a few lines about Daubrée's experiments, which almost bring a conviction that the majority of joints in subaqueous rocks are due to torsional strain?

In Part III., to which some of the above criticisms apply, we have a clear account of the way in which the crust of the earth is built up out of the materials described in Part II. Then follows Part IV., "The Geological Record of the History of the Earth." This must necessarily be presented in an abridged form, and if any fault is to be found with the way in which the subject is handled, it might perhaps be said that an attempt has been made to be rather too encyclopædic. Graphic pictures, such as the author can so well pen, of the physical geography of our own countay, and, where necessary, of the adjoining parts of Europe, during the different geological periods, would perhaps have been more acceptable and instructive to most of those who will read this book than palæontological details and accounts of the range of formations through other lands. For instance, the sketch of the physical geography of Europe during the Triassic period on p. 380, strikes us as singularly happy, and we should like to have seen more of the same kind of thing in the book. We all know how the pigeon-hole geologist deals with this question; how he produces his parallel ruler and divides his sheet of paper nearly into squares; how he puts the names of countries into the squares on the top line and the names of formations into the squares down one side, and then proceeds to fill in his puzzle. Under the column "England," line "Muschelkalk,' he inserts "Wanting." Ha! says he, a whole formation missing! great unrepresented interval! there must be a corresponding unconformity. Primed with this idea he now takes to the field, finds that the evenly-bedded New Red Marl does lie irregularly on the false-bedded sand-banks of the New Red Sandstone, and is overjoyed to see the unconformity which his chess-board told him must be there. Had he used, in trying to realise the meaning of the geological facts, half the ingenuity he showed in distorting them in order to fit them on to his Procrustean bed, he would have seen that what is called the Muschelkalk is not the only marine intercalation in the Trias of Central Europe, but that minor muschelkalks occur both in the Keuper and Bunter; that each of these marks an advance of the Triassic sea over the district where they are found; and that the reason why neither the great nor the little muschelkalks are found in England is that the sea did not succeed in pushing its way as far west as our country during any of its incursions. But there is no pigeon-holing in the book before us, and where the author has tried to bring before us a picture of the physical geography of bygone time, he has been so successful that we wish he had given us more of them.

A. H. G.

OSCAR SCHMIDT'S "MAMMALIA"

The Mammalia in their Relation to Primæval Times. By Oscar Schmidt. International Scientific Series. (London: Kegan Paul, Trench, and Co., 1885).

THE numerous and important discoveries that have been made in the last few years in extinct forms of mammalian life, and the light that has been thus thrown upon the relations of the surviving species, render a popular summary of our present knowledge of the class a very desirable undertaking. Moreover any work which, by showing the intimate relation of the present with the past, aids in breaking down the custom, which has descended to us from an antiquated condition of scientific culture, of treating separately of the existing and the extinct forms of life, of speaking of zoology and palæontology as if they were distinct subjects, must be welcomed by the philosophical naturalist.

In undertaking such a work the late Prof. Oscar Schmidt, of Strasburg (whose death we regret to say has been recently announced), acknowledges that he was departing from the specialty in which he had so highly distinguished himself, and was deriving his materials entirely from the researches of others. But the subject evidently had strong attractions for him, and he has most industriously and impartially compiled from the best authorities a work which, if it had been written in any one of the languages of the series of which it forms a part would have well served the purpose intended. The attempt, however, to give it a truly "international" character, by bringing it out in a combination of two languages, is unfortunately anything but successful. Words are continually occurring, which, though perhaps literal translations of German pseudo-vernacular expressions of modern manufacture, can convey no meaning to the English reader, whatever assistance he may get from the dictionary, as for instance, "spoon-dog" (for the African large-eared fox, *Otocyon lalandii*), "fingered-animal" (for Chiromys), "forked-animals" (for the Monotremata), "dog-fish" (for seal); and such expressions as "mid-jawbone," "root of the hand," "middle hand," "skiff-bone," and "spoke" are far less intelligible to the student of ordinary education than their generally-accepted scientific equivalents "premaxilla," "carpus," "metacarpus," "navicular," and "radius." Misprints and inaccuracies abound everywhere, such as the habitat of the small species of hippopotamus being transferred from Liberia to Siberia, the reference to "African armadilloes" and to Prof. Huxley's discovery of fibrous epipubic structures "in several hundred different species of dogs"! As a specimen of style we may quote the following sentence:—"When it is said that the Marsupials 'vicariate' in Australia for the other groups distributed on the other continents, this expression denotes nothing but the bare fact, nothing but the mere statement, that in America we do not meet with the camel but with the llama, which in a few main characteristics shows some affinity with it" (p. 13). With the general argument against the idea that the expression "vicarious," or, as English authors generally say, "representative," species offers no explanation of the facts of distribution we entirely agree, and we can even see what was floating through the author's mind when this extraordinary sentence was penned. The following description of the horn of the rhinoceros is however quite beyond our comprehension:—"The head weapons are solid horny projections of the nasal bone, which rise into a flat hump within equalities of the bone substance. From this characteristic feature it can in most cases be determined whether the fossil animals of the rhinoceros species possessed horns" (p. 194).

There is so much solid and useful information in the work, brought down to the most recently-published researches, as, for instance, those of Nehring, Branco, and Piétrement on extinct horses, that, if it had been subjected to careful revision by any one conversant both with the subject and the English language, it would have made a popular and readable manual of great educational value.

W. H. F.

OUR BOOK SHELF

Chemistry of the Non-Metallics. By E. B. Aveling, D.Sc. (London: Joseph Hughes, 1886.)

DR. AVELING tells us in the preface that "few people have as hearty a dislike for the whole system of examinations as himself. Theoretically, the object of the acquisition of knowledge is the bettering of human conditions. Practically, to-day the end and sole object is the passing of some examination"; after which the subject is shelved indefinitely in perhaps most cases. This seems to be the author's opinion, and it is doubtless correct in the main. But people who have even learned enough "*to pass*" one of the examinations the author names—the Matriculation (London) or the Elementary Stage (South Kensington)—must surely be in a better condition than before, spite of the inane questions the author speaks of as being set.

The extent of the book is to the so-called non-metallic elements only, their preparation, reactions, &c., and questions, including arithmetical problems, follow each element treated of.

The plan is very complete, perhaps too complete, for very young students such as we have nowaday. For instance, under the heading of each element is given—(A) Symbol, (B) weight number (atomic weight), (C) preparation, with several methods *in extenso*, (D) properties, with further numerated subsections 1 to 6, &c. Even Greek letters are used for "planning out" a property of a substance, &c.

Although the author starts by telling us how he dislikes examinations, his little book is eminently meant to cram students up for them. It is evidently intended to be used as a class-book, so that the beginner will have the assistance of a teacher to make a beginning.

There are a few misprints, and the descriptions are obscure in places.

Why do people who write little books always begin with hydrogen? In this book we begin with hydrogen, valency, ice, water, steam, latent heat, ammonia, and then come to oxygen, which has been spoken of as if we knew all about it. We certainly think, with most German teachers, that it is most logical to commence with oxygen and nitrogen and the atmosphere. There is much less knowledge of other substances to be assumed.

Hand-book of Mosses, with an Account of their Structure, Classification, Geographical Distribution, and Habitats. By James E. Bagnall, A.L.S. (Swan Sonnenschein and Co., 1886.)

THIS little book is a popular, but on the whole accurate, account of the best-known British mosses. The chapter on development, usually the weakest part of hand-books of this kind, is better than usual. We must however call attention to the confusion between "cuticle" and "epidermis" on p. 19, and to the unnecessarily bewildering description of the development of the spores on the following page.

The longest and also the best chapter is that on moss habitats, containing a very clear general description of the most important species, arranged according to the localities in which they are to be found. The following chapter, that on classification, is certainly not up to date, but perhaps the arrangement adopted is not intended for a natural one. The remaining sections, on distribution, cultivation, uses, and the preparation of specimens, are slight, but good as far as they go.

The book ought to be useful as an introduction to the systematic study of mosses.

D. H. S.

The Tourist's Guide to the Flora of the Alps. By Prof. K. W. v. Dalla-Torre. Translated and Edited by Alfred W. Bennett, M.A., B.Sc., F.L.S. (Swan Sonnenschein and Co., 1886.)

MR. BENNETT has introduced to English tourists a most convenient and useful Alpine flora. It is issued in a handy pocket-book form, and ought to be very popular with all travellers who take any interest in plants. The author had originally excluded the "commonest and most ubiquitous plants," but some even of these have been added by the translator, and all those natives of the Alpine districts which are not described in the flora proper will be found enumerated in an appendix.

Only two suggestions occur to us. Might not the often difficult work of identification be facilitated by the introduction of one or two analytical tables, such as those in Wünsche's "Schul-Flora von Deutschland?" They need not much increase the bulk of the book. And secondly, might it not be better, in a work intended for English tourists, and not for scientific men, to substitute English measures for those of the metric system? The latter ought by this time to be equally familiar with our own to educated people, but as a matter of fact we fear they are not so.

D. H. S.

Newton: His Friend: and His Niece. By the late Augustus De Morgan. Edited by his Wife and by his Pupil, Arthur Cowper Ranyard. (London: Elliot Stock, 1885.)

THE nucleus of the volume entitled as above was formed by an article written in 1858 for the *Companion to the British Almanac.* Its rejection brought to a close the remarkable series of Prof. De Morgan's contributions to that publication. The undivulged article, however, as years went on, grew by gradual accretions to the proportions of a book, now at last posthumously given to the world. Its primary object is to clear the character of Newton from the odious imputation of having countenanced immorality for the sake of personal advancement. This, in our opinion, has been satisfactorily attained. The researches here embodied afford strong grounds for the persuasion that there was no immorality to countenance. The sneer enshrined in No. 21 of Voltaire's "Lettres Philosophiques" (1765) thus at last loses its sting.

Catherine Barton, the "famous witty Miss Barton," as she was called in the *Gentleman's Magazine*, was the daughter of the Rev. Mr. Barton, by Hannah Smith, Newton's half-sister, and was born in 1680. Educated at the charge of her uncle, she came to keep house for him in London a year or two before 1700. Her beauty and brilliancy were the talk of the town, and won her the homage of men eminent for position and parts. She was amongst those whom Swift "loved best"; "j'ai conservé," Remond de Montmort wrote in 1716, "l'idée du monde la plus magnifique de son esprit et de sa beauté;" Charles Montague, Earl of Halifax, formed for her a devoted and life-long attachment. There is, in fact, strong presumptive evidence that she became his wife nine years previous to his unlooked-for death in 1715. The position, it is true, was never explicitly claimed by or for her; but silence might easily have been imposed by the inferiority of her social position. At any rate, a letter written by Newton to his kinsman, Sir John Newton, May 23, 1715, admits of but one interpretation. It includes the following sentence:—"The concern I am in for the loss of my Lord Halifax, and the circumstances in which I stand related to his family, will not suffer me to go abroad until his funeral is over." No "circumstances" existed which could possibly explain this allusion save one—that of a marriage between the deceased nobleman and the writer's niece. The words are used with no purpose of disclosure; they treat the fact they bear witness to as a known and indisputable one—known, that is, to an inner circle, where Catherine Barton moved all her life with the respect due to an unblemished character. Handsomely provided for by the will of Lord Halifax, she married, in August 1717, John Conduit, M.P., Newton's subordinate, and afterwards his successor at the Mint, and died in 1739, leaving an only daughter, ancestress of the present Earl of Portsmouth.

A considerable amount of elucidatory information regarding the marriage-laws and social usages of the last century adds to the value of the little work edited by Mrs. De Morgan.

Numerical Examples in Heat. By R. E. Day, M.A. (London: Longmans, Green, and Co., 1885.)

THIS is not merely a collection of numerical examination questions with the answers attached, but a well-arranged series of problems grouped under twenty-five heads, each beginning with simple questions, which increase in complexity. At the first introduction of every kind of question the answer is worked out in full, with a sufficient explanation to show the meaning of the operations. Other questions are given with their answers, but without the process of solution.

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. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Note on Sonnet to Pritchard

IN the general theory of algebraical forms there are two modes of defining an Invariant or Reciprocant. In the one mode either of them is regarded as subject to satisfy a partial differential *equation*—in the other as subject to *extinction* under the action of a partial-differential operator. Of course the difference between these two modes is one of presentation merely, and not of substance. Nevertheless it was interesting to me to observe that the very same rival concepts of *equality* and *extinction* lie at the root of the admirable investigations simultaneously carried on by Prof. Pickering at Harvard (who works by equation of light), and Prof. Pritchard at Oxford (who works by the method of extinction), which have earned for each of them the distinction of the award of the gold medal of the Royal Astronomical Society. I say *the* gold medal, because the medal to each is to be regarded in a transcendental sense as only one to both.

This reflection added to the sentiments of regard which I entertain towards my Savilian colleague caused me to write the sonnet in his praise, which you have done me the honour to insert in NATURE (April 1, p. 516), in which, owing to my own inadvertence the words *name* and *praise* have got interchanged. Being desirous that this tribute of unaffected admiration towards the subject of it should be affected with as few blemishes as are compatible with the feeble versificatory powers of its author, I request to be allowed to say that the first and last lines should read—

Pritchard! thy name is lifted to the skies,

and

Thy praise shall flourish in immortal song,

respectively. Also that the third and fourth lines should run thus—

To note each ray that gilds the hem of Night
Or eye her jewell'd brow with keen surmise.

At the dinner of the Fellows of the Royal Astronomical Society on the evening of the public presentation of the Medal to Prof. Pritchard, the sonnet was recited by its author at the desire of the Astronomer-Royal, who presided on the occasion.

J. J. SYLVESTER,
Savilian Professor of Geometry in the University of Oxford; and Author of "The Laws of Verse"

Fishery Board of Scotland

YOUR leading article of the 1st instant, headed "A Fishery Board for England," contains several inaccuracies with regard to the Fishery Board of Scotland which it appears desirable to correct.

(1) "If a Fishery Board is useful and valuable, it is a surprising fact that Ireland and Scotland have long enjoyed an institution which is wanting in England."

The present Fishery Board for Scotland was constituted only in 1882. Prior to that date there was a Board of Fisheries which, from its origin in 1808 until 1820, confined its attention to the curing and branding of herrings, and to collecting statistics of the quantities of herrings landed and exported. From 1820 to 1881 statistics of the cod and ling cured were also prepared. This Board of Fisheries having charge of all the fisheries around the coast of Britain, appointed officers at the chief Scottish and English fishing ports, two of whom were stationed in London, from which in the beginning of the century large consignments of herring were sent to the Continent. In course of time the number of herrings cured at the English stations became so small that in 1850 the English Fishery officers were dismissed. In fact, the old Fishery Board existed chiefly in order to collect statistics of cured fish and to superintend the curing and branding of herrings. It will be understood how exclusively attention has been devoted to these objects when it is mentioned that even now the Fishery officers must be practical coopers.

(2) "The Commission for the Investigation of the German Seas is composed of distinguished men who are students and teachers of biology or physics. In Norway and Holland the same thing occurs."

We believe it is a fact that neither the Norwegian nor the Dutch Government has yet instituted Fish Commissions.

(3) "A large number of matters connected with the fisheries have not yet begun to receive attention even in Scotland."

It was only in 1883 that the Scottish Fishery Board obtained from the Government a sum of 300*l*. for studying the life-history, &c., of the food-fishes, and the total sum received up to the end of last month was only 2800*l*. When it is remembered that a sum of 10,000*l*. has been required to found the laboratory of the Marine Biological Association, it can scarcely be deemed a matter of surprise that many topics of interest and importance have not received from the Scottish Fishery Board that degree of attention which they deserve.

(4) "The spawn of the sprat is still entirely unknown."

Mr. Duncan Matthews, of the University of Edinburgh Zoological Laboratory, in his "Report on the Sprat Fishing during the Winter of 1883-84," published in the Report of the Fishery Board for Scotland for 1883, describes and figures the "spawn" of the sprat.

(5) "The Scottish Fishery Board is about to try an extensive experiment with regard to beam-trawling, prohibiting that method of fishing in certain defined areas. The experiment is worth trying, even at the cost of temporary inconvenience to the fishery industry. But in order to render such an experiment fruitful, it would be necessary to make a detailed and exact investigation of the areas selected. It is doubtful whether the organisation of the scientific department of the Scottish Board is yet in a position to make this investigation in a sufficiently complete manner."

Seeing that he appears to speak as one having authority, and not as the scribes, it is gratifying to note that the writer of your article deems "the experiment worth trying." We have only to regret that he appears to view with suspicion the competency of the scientific department of the Fishery Board to try it. Perhaps it may serve to reassure him on this point to learn that these suspicions are not in any way shared by the Government, who have now furnished the means for purchasing a steam-vessel for trawling; for maintaining three laboratories (one of them with a large number of tanks); and for securing the assistance of three skilled naturalists who will work in conjunction with Profs. Ewart and McIntosh, to whom your contributor alludes.

S. F. B.

Protective Influence of Black Colour from Light and Heat

THE difficulty of explaining the black colour of races near the Equator has long been felt. Strong sunshine undoubtedly tends to darken the skin; but if black, as generally supposed, is the colour that absorbs most heat, natural selection should have developed white as the complexion best adapted to shield mankind from the intense radiation of an equatorial sun.

Without venturing to offer an opinion on the subject, I should like to mention three cases that have come under my personal observation, in which brown-skinned natives, in very different parts of the world, blacken their faces to protect them from intense light and heat.

In Morocco, and all along the north of Africa, the inhabitants blacken themselves round the eyes to avert ophthalmia from the glare off hot sand.

In Fiji the natives, who are in the habit of painting their faces with red and white stripes as an ornament, invariably blacken them when they go out fishing on the reef in the full glare of the sun.

Lastly, here in the Sikkim hills the natives blacken themselves round the eyes with charcoal to palliate the glare of a tropical sun on newly fallen snow.

This I had an opportunity of experimenting on. We were caught in a snowstorm at an elevation of 10,000 feet; when it subsided all the coolies blackened their eyes, so I had one eye blackened, the other left natural, and went out into the sun for half an hour. I cannot say that I felt much difference. Next day I tried marching for about six hours, up to 12,000 feet, with both eyes blackened. I cannot say how far this may have been palliative, but the glare was so bad, we were all very glad when the mist came up and obscured the sun. Radiation is far more intense at high altitudes than at low levels. Still it is impossible to suppose that three such different nations would have adopted the same device to mitigate sun glare if black colour did not give some palliation at least.

Here then we have one of those strange anomalies in which physiological experience contradicts the teachings of pure physics. Charcoal black, which is used in physical experiments as the best absorbent of every kind of heat radiation, is practically used by three races at least, to protect one of the most sensitive human organs from reflected light and heat. Of course I cannot offer any explanation, but bring the facts to the notice of those who have the skill and opportunity to make physiological experiments, in the hope that they may perhaps find a clue to the long-sought-for explanation of the colours of the human race.

RALPH ABERCROMBY

Darjeeling, March 15

Pumice on the Cornish Coast

ABOUT a month ago I picked up on Maenporth Beach, near Falmouth, a piece of drift pumice of the size of a large goose's egg. It was rounded, floated heavily, and was just twice the weight of a piece of Krakatão pumice of the same size which had been obtained in the Indian Ocean several months after the eruption. No Cirripedes, Serpulæ, &c., had attached themselves to it; but in one of its crevices I found a tiny dead coleopterous insect, which I unfortunately lost. From my familiarity with floating pumice in the Western Pacific I at once perceived that this fragment had been a considerable time in the water. After searching the other beaches in the neighbourhood I failed to find another piece. Mr. John Murray, to whom I sent the specimen, informs me that he has similarly picked up fragments of pumice on the west coast of Scotland.

Without speculating on the source of the fragment found on the Cornish beach, I should remark that, judging from an experiment made in the Western Pacific, pumice may float for several years on the sea before it becomes sufficiently sodden to sink to the bottom. I kept floating in sea-water for two years and nine months three pieces of pumice which I originally obtained in the tow-net whilst cruising in the Solomon Islands. Although they had evidently been a long time in the water before I got them, since they floated heavily and had in two cases the tubes of Serpulæ attached, the only apparent alteration in their buoyancy produced by my experiment was that one which floated in fresh water when I first obtained it now sank. How much longer they would have continued to float in the sea-water I cannot say. From their condition before the experiment they must have been previously floating for even a longer period.

H. B. GUPPY

95, Albert Street, Regent's Park, April 10

The Connection between Solar and Magnetic Phenomena

IN the discussion which followed the reading of Prof. Balfour Stewart's paper on magnetic declination, at the Physical Society, considerable weight was attached to Carrington's observation of a solar outburst observed on September 1, 1859, and the simultaneous occurrence of a movement of the magnetic needles at the Kew Observatory.

Nearly twenty-seven years have now elapsed since the event referred to took place, and both the sun's surface and the magnets have been under observation thousands of hours since that time.

Hundreds of magnetic movements similar to that above mentioned have been recorded since, and I should deem it a great favour if any correspondent would either inform me of the time or times of similar outbreaks to that seen by Carrington, if such have been observed, or refer me to any published accounts of the phenomena.

Carrington's paper is published in the *Monthly Notices* of the R.A.S. vol. xx. p. 13.

G. M. WHIPPLE

Kew Observatory, April 12

Aurora

A BRIGHT Polar light was observed here on March 30 from 8 to 11 o'clock p.m., how long it had lasted I cannot tell. At 8 o'clock only flashes of a pale blue were seen about the Pleiades; their brightness was changing very quickly; at 11 o'clock across the whole northern sky there lay the well-known dark segment with the bright arch above; from the latter only a few reddish beams of light were seen emerging.

Königsberg i. Preussen H. FRITSCH

Was it an Earthquake?

YESTERDAY morning (Thursday, April 8), at 5.35, the door of my room vibrated regularly for about three or four seconds. I did not perceive any motion of the room itself. I was up at the time, and quite still. Perhaps the best way of finding out whether anyone else experienced anything of the same nature, so as to determine whether it was in any way connected with an earthquake, is to write to NATURE.

Ladbroke Gardens, W., April 9 A. TREVOR CRISPIN

"Radical" or "Radicle"

MR. MADAN in his amusing letter last week (p. 533) raises a point which has doubtless often caused the comments of teachers. I think "a partical of reasoning" at least *can* be adduced in favour of "radical." In this paradoxical world it is not surprising to find that "radical" is the "conservative" and "constitutional" spelling, and that "radicle" is a radical alteration in a centenarian word. For next year will be the hundredth anniversary of what was, if I am not mistaken, the first use of the word by Guyton de Morveau. It seems to have long retained its French spelling, and I think it would be a pity to alter one which thus recalls to the memory a host of great names, and perhaps more than any other single word in chemistry suggests the international brotherhood of scientific men. Of course Mr. Madan's protest has force from the grammatical point of view; it may also be urged that "radicle" is English for the French "radical." But from the chemical standpoint surely the "radical" is as much a "stem" as a "root"? For instance toluene is either $C_6H_5(CH_3)$, or $CH_3(C_6H_5)$, and it would be arbitrary to select from a very limited number of reactions *the* "root" in prussic acid, H.CN, C.NH, or

N.CH. Many chemists prefer "grouping," a safer word often used by Prof. Odling in his lectures.

After all, the question is really a gnat amongst the camels of our present nomenclature in organic chemistry. The sooner the last straw comes the better. What would Morveau or Lavoisier say, for instance, to "dimethyldiethylhydroxytrimethylenecarboxylic acid (1, 3, 2, 3, 2, 1)," in Dr. Perkin, Junr's., paper, *Journal* Chem. Soc., 1885, p. 807? Chemists who doubt the propriety of spelling a word in two ways must have excessive sympathy with the geographers who are trying to get their brethren to select one of over forty different "spellings" of Fuchau or Foo-Chow. J. F. HEYES

12, Merton Street, Oxford, April 12

Square Bamboo

NATURE was so good as to publish (August 27, 1885), a communication from Mr. W. T. Thiselton Dyer in relation to my discovery of the square bamboo. Supplementary to the information therein given I send the following which I have just met with in a Chinese work:—"It grows wild in the north-eastern portion of Yunnan on the sequestered mountains of Takuan-ting and Chênhsing-Chou, to which in spring men, women, and children resort for cutting its shoots, which they tie in bundles and send to market. It is prized above all other bamboo shoots as an esculent." D. J. MACGOWAN

Wenchau, February 8

Ferocity of Animals

ALTHOUGH the animals in question are not rats, it may interest Mr. Romanes to hear that some years since a friend was on a railway journey in the north, having with him two large dogs. These were confined together in the brake-van. During the journey one of these dogs (a bull-dog) attacked and seriously injured the other (a retriever, if I remember rightly), although ordinarily they were very much attached to one another. My friend's idea was that the bull-dog became frightened at the motion of the train, which oscillated considerably, and imagined that the other dog was the malefactor. This may be merely theory, but the case perhaps is worth noting. UNUS

Birkbeck Institute, April 6

MR. VERBEEK ON KRAKATÃO

MR. Verbeek's work on the Krakatão eruption has now been completed. The first part, which deals principally with the history of the great eruption, came out more than a year ago, and has been made accessible to English readers in a French translation. It was desirable, says Mr. Verbeek, in his introduction to the second part, of which an abstract is given here, that that portion of the work should appear as soon as possible, to contradict the many untrue statements that had found their way into the newspapers, and even been partially adopted in scientific magazines.

The second part, a quarto volume of some 500 pages, with additional drawings and maps, which will likewise shortly appear in French, gives an account of the phenomena observed both during and after the eruption, besides a description of the old Krakatão. Mr. Verbeek's task has been a very laborious and comprehensive one, for while the consequences of most eruptions are confined to the immediate neighbourhood of the volcano, those which followed the great Krakatão eruption have been observed all over the earth, and have as much interest for the hydrographer, the meteorologist, and the astronomer, as for the geologist.

It may be said without exaggeration that the Krakatão eruption has been the most remarkable catastrophe of the kind of which the human race has kept a record, for, though other eruptions, such as that of the Tomboro in 1815, no doubt caused important atmospheric disturbances, there were no instruments at that time to make accurate observations, and thus they were lost for science.

How invaluable the self-recording barometers and tide-gauges have been on this occasion has been conclusively shown, but the number of these instruments is comparatively small, and Mr. Verbeek hopes that his work may lead to an increase of the number of barographs which mark the atmospheric pressure as an unbroken curved line, and especially of self-registering tide-gauges at favourable points on the coasts, and on various islands in the ocean.

In spite of the assistance Mr. Verbeek gratefully acknowledges to have received from innumerable persons in obtaining accurate information, he has had much difficulty in sifting the often conflicting evidence. Even now a few data are wanting, which will probably make an appendix necessary.

As the work with which the Dutch Indian Government had intrusted him would take a considerable time, they wished him to issue a preliminary report[1] which had necessarily to be drawn up in a limited period before the close examination of the volcanic substances could have taken place. Mr. Verbeek had in consequence to modify some of the views he expressed there. For instance, he no longer considers the balls of marl to have been produced by a rapid revolving motion of marl, mud, or sand, because at a later period similar balls were found in claystones, and thus were shown to have already existed before the eruption. He was also obliged to give up the notion that the dust found in snow and rain in various parts of Europe was derived from Krakatão. A slight modification had to be made in the time when the four greatest explosions occurred, and a more considerable one in the time of the rising of the greatest wave. Hence also the figures given for the medium depths of the sea had to undergo an alteration. Finally, the composition of some of the volcanic products was accurately determined by a later and more elaborate chemical analysis, and it was proved that the percentage of silica given in the short report is generally too large. Those are the only modifications of any importance which Mr. Verbeek says he had to make in the preliminary report.

The book—which he has spared no pains to make as complete as possible, and which is indeed the most complete work of the kind ever written—will, he hopes, serve as a standard guide for any future eruption of the same magnitude that might still occur in this century. In such an undesirable but not improbable contingency a great deal of trouble will be saved by referring to its pages, where information laboriously collected from innumerable sources may be found, as well as elaborate calculations which will not require to be repeated.

No hypotheses are offered for explaining the unusual number of volcanic phenomena in 1883, because every certain foundation is wanting. If the cause of eruptions is to be found in the first place in the water penetrating from the surface into the interior of the earth, and if their multiplicity must therefore be traced to the formation or opening up of lines of dislocation, or to subterranean subsidences, which both facilitate the access of water and increase the pressure in the subterranean regions, there still remains the question what specially produced these altered conditions in 1883.

A connection has been supposed to exist between the volcanic phenomena on the earth and the intense activity of the sun in that year. The maximum of the sunspot period seems to fall on 1884·0, thus a few months only after the eruption. The interesting researches of Prof. R. Wolf at Zürich have shown a connection between the number of sunspots and the daily variation of the magnetic declination. At a maximum of the spots, therefore, strong terrestrial magnetic currents might arise which might produce chemical disturbances in the interior of the earth that would be favourable to earthquakes or eruptions; but it must not be forgotten that at the periods 1829·9, 1837·2, 1848·1, 1860·1, and 1870·6 maxima

[1] This report appeared in NATURE, vol. xxx. p. 10.

of sunspots likewise occurred, of which those of 1837 and 1870 were almost twice as great as the maximum of 1884, whereas those years were not marked by any special volcanic activity. Mr. Verbeek cannot, therefore, see any connection between the activity of the sun and that of the earth in 1883, nor does he believe the position of the earth with respect to the moon and sun had any relation to the great eruption of August. The following is Mr. Verbeek's summary of what the eruption has specially taught us :—

(1) The extraordinary loudness of the sounds deserves, in the first place, our attention. The substances were shot out of the crater with great velocity up to a very considerable height, and this was accompanied with detonations which far surpassed in power all the sounds with which we are acquainted. Never were sounds heard over such a large area of the earth's surface during any previous catastrophe. Some time ago, in the French Academy (*Comptes rendus* du 9 Mars, 1885), the possibility even of the transmission of these sounds through the earth's centre, straight to the antipodes of Krakatão, was suggested. According to a communication from M. F. A. Forel, reports were heard on August 26 on the Island of Caïman-Brac in the Caribbean Sea (south of Cuba, 80° W. long. from Greenwich, and 20° N. lat.). The exact hour is not given; but from the account it appears clearly that the reports were heard in the *daytime*. (The sky was clear. People ran to the shore to see whether a ship was approaching, &c.) For several reasons it does not seem to me very probable that these sounds proceeded from Krakatão. In the first place, at the time of the great eruption in the Straits of Sunda, there appear to have been eruptions near the antipodes, though the details are wanting. In the second place, it is probable, for other reasons, that an earthquake or eruption occurred in or near the Caribbean Sea. Thirdly, the time does not agree; for if, according to M. Forel, an hour be allowed for the transmission of the sound through the earth's centre, which is probably too little, the great detonations of Krakatão could not have been heard at the antipodes in the daytime, but only late in the evening of August 26.

(2) These stupendous detonations caused such violent disturbances in the atmosphere that many objects at long distances from the volcano underwent a corresponding vibration of such intensity as to suggest the idea of an earthquake.

(3) The formation also of an atmospheric disturbance which propagated itself in very long air-waves round the earth's surface is a phenomenon which had not yet been observed in connection with eruptions, though other atmospheric disturbances had been previously understood to have regular wave-motions.

(4) The phenomena of the green and blue sun and moon, and of the beautiful red glow, had been already observed after eruptions, but not with such intensity as after August 1883.

(5) Though the truncated cones of many volcanoes had been previously recognised as the remains of conical mountains which had had their summits flattened by a subsidence of the central part, we have here for the first time witnessed a subsidence which agrees in dimensions with the Tengger in East Java, known to be one of the largest subsided crater areas in the world. The explanation, which was hitherto considered a doubtful one by some on account of the enormous dimensions ascribed to the subsided part, has been entirely confirmed by the catastrophe at Krakatão in 1883.

(6) The almost vertical section of the peak Rakata,[1] accidentally formed by the eruption, has given us a very valuable insight into the internal structure of a volcano. Of course this formation is by no means the same in all volcanic conical mountains; thus for instance in many volcanoes the existence of a hollow space or a compact kernel may be considered probable, though the Rakata section does not exhibit this.

(7) By the subsidence into the sea of part of the peak, waves arose which far surpassed in elevation the biggest ever formed in a storm. To this additional catastrophe, which caused the inundation of the coasts in the Straits of Sunda, the large number of victims of the Krakatão eruption must be attributed.

(8) The propagation of this wave-motion is very remarkable. Not only in the whole of the Indian Ocean, but even in the Atlantic and the Pacific Oceans, disturbances were observed which were caused by the Krakatão wave. Part of the disturbances, however, observed in the state of the water on the coasts of America and Europe, which were originally also attributed to Krakatão, must have had another cause.

(9) It is known that, from the velocity with which the wave-motion is propelled, the medium depth of the sea may be calculated along its path. Upon the route from Krakatão to South Georgia it is found that the rate of velocity is equal to the extraordinary depth of 6340 metres. Over that track there lies to all appearance a deep basin, the probable existence of which will, I hope, be shortly confirmed by deep-sea soundings.

(10) Finally, a very remarkable result of the analysis of the Krakatão ashes deserves mention. These ashes, namely, are the first rocks in which a very great number of plagioclase species of felspar have been found together. While in many rocks of volcanic origin various triclinic felspar species (usually two) had been previously supposed or shown to exist, it was proved for the first time by the analysis of the Krakatão ashes that one rock may contain *all* the plagioclases, from the most basic to the most acid. There appears, besides, a little sanidine. All these felspars are, in this instance, products of the first crystallisation, as the second crystallisation was prevented by the sudden cooling and consolidation of the melted rock magma. Tschermak's theory of felspar finds a fresh support in this simultaneous presence of plagioclases whose specific gravity diminishes gradually from that of pure anorthite to that of pure albite.

That which has been easily proved in this case by the isolated condition of the crystals, we may take as highly probable for many compact andesites, and even for a large number of other eruptive rocks, namely, that among the porphyritic felspars there are a variety of species, which differ in specific gravity, and therefore also in chemical composition.

If on two corresponding rectangular axes, with the specific weights as abscissæ, the analogous quantities of plagioclase which a rock contains are put as ordinates, a number of points are the result, of which the junction gives a curve which may be called the "felspar curve" of the rock. This curve must necessarily take a very different course for the different acid and basic stones. It is a new and interesting task for petrographers to determine the "felspar curve" of the principal eruptive rocks.

[1] The old name, of which Krakatão is a corruption, and which is still given to the peak itself.

THE PLEIADES

IT is a singular circumstance that the oldest-known mode of determining the seasons and directing the recurrent operations of human industry, should also have been the most widely diffused. Nor was this an obvious one. It regarded directly neither of the two great luminaries, which, as they move, might almost be said visibly to pay out a golden cable of time; but turned, instead, to a comparatively inconspicuous, though beautiful and eminently interesting, group of stars. The periodical shiftings in the sky of the sun and moon force themselves upon the dullest apprehension; one must, however, be already something of an astronomer to take any close heed of stellar configurations. Yet all over the world, in the northern and southern hemispheres, amongst Polynesian and Australian savages, as well as under the sway of Egyptian, Peruvian, Mexican, early Hellenic, and Indian civilisations, traces are found of a primitive calendar regulated by the risings and settings of the so-called "Seven Stars."[1]

Only 6 Pleiades, indeed, are usually visible, although 12, 14, even perhaps 16, have been made out without optical aid by exceptionally keen and vigilant observers. Hipparchus is probably the only astronomer of antiquity who mentions the possibility of discerning a seventh member of the family; and he admits that it could be seen only under a transparent sky and in the absence of the moon. Thus Ovid's well-known line in reference to the group,—

"Quæ septem dici, sex tamen esse solent,"—

quite correctly describes its ordinary visual aspect. Nevertheless, it figures as septuple in the folk-lore of well-nigh all the peoples of the globe, from the Baltic to the Tropic of Capricorn; and the aborigines of Victoria, no less than Greek poets, have sought, by appropriate inventions, to reconcile what was apparent with what was assumed. It is altogether uncertain whether the story of the "lost Pleiad" is a tradition or a myth,—whether it commemorated an actual prehistoric occurrence, or merely supplied by fable the unit wanting to complete a consecrated number. There is no manner of doubt, however, that it is cosmopolitan and immemorially antique. Before dismissing it as an idle fancy, it may be worth while to inquire into the probability of a real loss of lustre in an originally manifest companion of Alcyone.

The spectroscope affords some grounds for a *primâ facie* presumption *against* marked variability in these associated stars. With one or two quite insignificant exceptions, they all shine with the bluish-white radiance, and display the brilliant spectrum obscured only by hydrogen-absorption, of which steadfast emission is usually the concomitant. Usually, but not invariably. There are noted instances to the contrary, which further experience may perhaps multiply. It is, at any rate, certain that perplexing anomalies have hitherto been found to affect photometric estimates of the Pleiades.

Very little reliance can in general be placed upon early accounts of relative stellar brightness; yet it is startling to find that Ptolemy enumerates four individuals of the group, none of which can be identified with its now pre-eminent member. Either, then, his description is strangely misleading, or Alcyone was not, 1750 years ago, the *lucida* of the collection. Francis Baily, who well knew how to make allowance for ancient inaccuracy, considered that this star, if observed at all by the Alexandrian astronomer, must then have been of far less magnitude than now (*Memoirs R. Astr. Soc.*, vol. xiii. p. 9). Further, Abdurrahman Sûfi, who professed, in the tenth century, to have corrected, from personal observations, the catalogue of his predecessor, expressly states that Ptolemy's quartette were re-specified by him as being the most conspicuous of the Pleiades (Flammarion, "Les Étoiles," p. 294). But Alcyone, as we have seen, was certainly not amongst them. The leading position it still occupies was first, some six centuries later, assigned to it by Tycho Brahe. That there have been fluctuations of lustre among its attendant stars has, by the recent inquiries of Wolf and Lindemann, been rendered certain in a few cases, and highly probable in many more. Room for doubt on the point will presumably ere long be narrowly limited. By means of his "wedge photometer," invented for the special purpose of introducing harmony into the light-measurements of the Pleiades, Prof. Pritchard has accumulated materials for future comparisons, vouched for as trustworthy by the satisfactory agreement between his estimates of magnitude and those arrived at by Profs. Lindemann and Pickering. In the meantime there is sufficient authentic evidence of variability in the group to render the literal explanation of the disappearance of the seventh daughter of Atlas a plausible one.

The oldest existing map of the Pleiades was constructed by Maestlin in 1579. It deserves attention as a curiosity of archæological astronomy, and as exhibiting eleven stars, discerned, of course, with the naked eye.[1] Galileo made the first telescopic survey of the group, of which he detected, with his feeble instrument, nearly 50, and graphically recorded the positions of 36 components. De la Hire, Cassini, and Jeaurat followed, the last mapping and cataloguing at the École Militaire, in 1782, 64 leading Atlantids (*Mémoires de l'Ac. des Sciences*, 1779, pub. 1782, p. 505). In publishing, in 1841, differential measures, with the Königsberg heliometer, of 52 of these stars (*Astr. Nach.*, No. 430)—besides Alcyone, the place of which was fixed by observations in the meridian—Bessel had another end in view than mere enumeration. He designed to establish a term of comparison from which their mutual displacements might hereafter be determined. And, in fact, the prospect of gaining some real knowledge of such displacements would be still remote, were it not for this anticipatory labour. Dr. Gould was the first to turn it to account. He obtained, it is true, only a negative result, but one memorable as the earliest in sidereal science derived from the use of a method then in its infancy, but now, within a score of years, grown to be of overwhelming importance.

With an object-glass 11 inches in diameter, corrected for the ultra-violet rays, Lewis M. Rutherfurd, of New York, took, in 1865, some admirable photographs of the Pleiades (*Observatory*, vol. ii. p. 16). One of them, now in the possession of the Royal Astronomical Society, remarkably exemplifies the capabilities of the old collodion-process. The time of exposure is not known, but was probably short, since there is scarcely a trace of irradiation, and the stellar impressions are minute and beautifully distinct. They are thus peculiarly susceptible of exact measurement. The right ascensions and declinations of nearly fifty Pleiades, hence deduced by Gould, showed so close an agreement with Bessel's, as to make it fairly certain that no appreciable change in their relations had taken place within a quarter of a century.

This conclusion was somewhat modified by the results of M. C. Wolf's laborious investigation at Paris ten years later (*Annales de l'Observatoire*, t. xiv. 1877)—probably the last aiming at exhaustiveness for which merely visual data will furnish the materials. His chart includes all stars down to the 14th magnitude, to the number of 625, contained in a rectangle 135′ by 90′, in which Alcyone occupies a nearly central position. Of these, 571 are catalogued, while the places of 79 are determined with the utmost nicety, and compared with those assigned at Königsberg. The upshot went to show unmistakably a community of backward drift, reflected from our own advance through space. Alcyone has a well-marked, though small, proper motion, in a direction exactly opposite to that of the solar translation. The invariability of relative situation in its crowd of companions, inferred by Gould in 1866, hence really amounted to a demonstration of the existence of a physical tie between them. For it proved that the whole cluster was pursuing an identical line of march in the sky. Even though that march be purely a parallactic effect, the force of the argument remains untouched. Unanimity in apparent movement implies a real aggregation equally with unanimity in rapid actual progress.

Other, and if possible more cogent, proofs of the close relationship of these clustered stars are now, however,

[1] See R. G. Haliburton's "Festival of the Dead," and Bunsen's "Die Plejaden und der Thierkreis."

[1] For a map by Miss Airy of 12 Pleiades from ocular view see *Monthly Notices*, vol. xxiii. p. 175.

gradually becoming available. The presence of minute displacements connected with the internal economy of the system, emerged pretty clearly from Wolf's inquiries; although their direction and amount remained little more than conjectural. The main fact indicated is that of an extraordinary complexity in the governing plan of the assemblage. It appears to embrace a great number of binaries, and at least one triple star, which pursue their separate revolutions independently of the higher systemic relations which no doubt bind and sway them. Each of the pairs, for instance, numbered 9, 10, and 31, 32, on Bessel's list, gives signs of orbital movement; while the beautiful little triangle of 8th-magnitude stars close by Alcyone is (seemingly) in slow process of deformation.

Fresh evidence was deduced from a set of elaborate measurements of forty stars in the Pleiades, completed by Prof. Pritchard in 1884. To fourteen amongst the number, two independent processes were found applicable. Meridian observations extending over 130 years afforded, when reduced, the means of ascertaining their absolute co-ordinates and proper motions; and these were compared with the results of micrometrical determinations of relative position at Königsberg, Paris, and Oxford, 1838 to 1880. Both methods agreed in pointing to certain shiftings *inter se*, just, as it were, nascent, and demanding a further lapse of time for the development of the scheme they are conducted upon. Enough, however, was made out to show plainly that no mere incongruities of proper motion, or perspective displacements consequent on change in our own point of view, were concerned, but real effects of gravitative action amongst a group of mutually connected bodies.

Thus at last we seem to be on the verge of learning something of the interior mechanism of a star-cluster, the extraordinary difficulty of the problems presented by which has hitherto almost silenced speculation. The facilities for collecting the necessary data offered by the recent enormous improvements in stellar photography, will doubtless help to stimulate the inquiry, as well as to assure its conclusions.

Our readers are already familiar with the first results in photographic star-charting secured by means of an apparatus constructed (as to its optical part) by MM. Paul and Prosper Henry, and mounted in the garden of the Paris Observatory in April 1885. These have been followed by four photographs of the Pleiades, taken respectively on November 16, December 8 and 9, and January 8, of surpassing beauty and interest. The exposure was in each case of three hours, during which long period the following of the diurnal movement appears to have been absolutely perfect. No mechanism is adequate to effect this with the requisite nicety; the eye and hand of the operator are an indispensable adjunct. An $11\frac{1}{2}$-inch telescope, adapted for visual use, inclosed in the same metallic tube with a photographic object-glass $13\frac{1}{2}$ inches in diameter, serves accordingly as a channel of communication with the sky, through which the progress of the operation is surveyed, and timely notice derived of the need for controlling incipient inequalities.

On the plates thus exposed, above a thousand stars—all presumably belonging to the same magnificent cluster—are clearly imprinted. They range down to the 17th magnitude, many of them being beyond the power of any telescope hitherto constructed to disclose to the eye. But the retentive "photographic retina" has time on its side. Such extraordinary success in registering the faintest objects necessarily implies considerable over-exposure in regard to bright ones. It is indeed found that the time of *pose* for a star of the sixteenth is no less than *one million times* than for one of the first order of lustre (MM. Henry, *La Nature*, December 5, 1885). This disparity constitutes perhaps the most serious drawback to the photographic method of charting. It has, however, the counterbalancing advantage of supplying tolerably accurate indications of magnitude in the varying size of the stellar disks.

The importance of these remarkable pictures is one which the lapse of centuries must tend to heighten. They will place future astronomers in possession of documentary evidence of ever-growing value. Their historical function, however, does not stand alone. They have also unexpectedly served the purpose of present discovery. A small nebula of a spiral form, encircling the 5th-magnitude star Maia, of which no visual trace had ever been perceived, comes out with surprising intensity on all four plates. It consists of a single whorl resembling a strongly-curved cometary train, and extends on one side so as to involve a minute adjacent star, which might be thought to play the part of a secondary nucleus. The configuration recalls the tendency to a duplicate structure visible in the great spiral in Canes Venatici, as well as in other similar formations. The photographic strength, in proportion to the curious optical weakness of the new nebula, suggests that its rays are situated mainly in the upper part of the spectrum, and that it is of a gaseous constitution. Spiral nebulæ conform to no fixed rule in this respect. The first recognised and most striking member of the class (that in Canes, 51 Messier) emits continuous light, while several others show bright lines. Amongst these would most probably be found the specimen just discovered, were it possible to submit its feeble light to analysis. This probability is greatly strengthened by Mr. Lockyer's recent detection in the spectrum of Maia of bright lines, as yet, however, undetermined in regard to position.

Photographic discovery led the way to, and was quickly followed by, visual detection. On February 8 Admiral Mouchez communicated to the Paris Academy of Sciences a telegram from M. Struve announcing that the Maia nebula had just been successfully observed with the 30-inch Clark achromatic recently mounted at Pulkova. This promising *début* by the largest refractor yet constructed, encourages the hope that the limit of useful size has not yet been reached.

The singular vortex round Maia is not the only nebula in the Pleiades. At Venice, on October 19, 1859, M. Tempel, who had then lately exchanged his profession of an engraver for that of an astronomer, discovered an extensive nebulosity of an elliptical form, encompassing, and stretching southward from, the star Merope. The history of its subsequent observation is not a little curious. Unaccountable discrepancies have perplexed the evidence of its existence. Some of the finest instruments in the world have persistently refused to disclose it, while at times it has been plainly visible with glasses too insignificant to serve as their finders. Messrs. Hough and Burnham have uniformly failed to perceive it with the great Chicago refractor. Prof. Pritchard, during the whole course of his assiduous study of the group, has never detected a nebulous indication connected with any of the stars composing it. D'Arrest only succeeded in seeing it in 1862 after two years of fruitless searching, and considered it the faintest object he had ever viewed with the 11-inch Copenhagen refractor (*Astr. Nach.*, No. 1393). Nevertheless Schiaparelli, February 25, 1875, found it to extend past the star Electra as far as Celæno, and gave it as his opinion that it was a striking object in a clear sky (*Astr. Nach.*, No. 2045). The late Dr. Schmidt, of Athens, had no doubt at all of its variability. Mr. Lewis Swift, of Rochester (N.Y.), on the other hand, who, unaware that it existed, "ran upon it" accidentally in 1874, watched it carefully during seven years without perceiving a sign of change (*Monthly Notices*, vol. xlii. p. 107). Its presence is to him palpable. A 2-inch aperture with a power of 25 suffices to reveal it. M. Tempel himself has always seen it in its original form. Mr. Maxwell Hall, in Jamaica, has never looked for it in vain with his 4-inch achromatic. Schönfeld described it as "very distinct and immediately conspicuous" (Tempel, *Monthly Notices*, vol. xl. p. 622).

The truth seems to be that, whether variable or not, it is one of the most sensitive objects in the sky. The slightest haze suffices to obliterate it. Air so translucent as to allow 13th or 14th magnitude stars to shine clearly may still contain mist enough to shroud the Merope nebula. Nor will it endure high magnification. Its scanty rays need to be condensed into a small image to become sensible, while, in the restricted field of a great telescope, they are apt to leave the eye unaffected for want of a contrasted black background. Even the enormous light-grasp of the Rosse reflector was unavailing to show this delicate object until the lowest possible powers were applied. Idiosyncracies both of instruments and observers have besides tended to widen divergences of opinion. Some eyes appear to be incapable of discerning an illumination so faint and diffused. Nay, telescopes of equal apertures are not perhaps devoid of "personality" regarding it.

Still more difficult to explain than its anomalous invisibility, are the differences in its aspect when seen. Goldschmidt made the supposed discovery in 1863 (*Les Mondes*, t. iii. p. 529) that it was no isolated formation, but a spur or projection inwards from a vast nebulosity 5° in diameter, in which a blank central space similar to that left clear for the trapezium in the Orion nebula, was occupied by the entire group of the Pleiades And Wolf, after careful consideration, adopted this view in 1876. Other observers have seen several distinct patches in lieu of the large misty ellipse, about 35′ by 20′, in which M. Tempel could just distinguish the beginnings of two nuclear condensations. Engelmann's map of the Pleiades, published in 1876 (in Bd. ii. of Bessel's *Abhandlungen*), shows a mere nebulous wisp to the south of, and apparently unconnected with, Merope. Two such were observed by MM. Baillaud and André, at Paris, March 7, 1874, and form the regular aspect of the nebula as viewed with Mr. Pratt's 8-inch mirror. Mr. Common's great speculum disclosed to him, February 3, 1880, a triple and considerably scattered group, with unmistakable symptoms of an extension north-west towards Electra. Now at last the camera steps in as arbiter between conflicting observations. The Paris photographs decide at once the Merope nebula to be no such illusory object as has sometimes been supposed. It really exists; but in a shape *at present* strangely varied from that of its earlier appearances. Only its position on either side of the star Merope identifies the irregularly striated formation visible on the plates, with the uniform train of almost evanescent luminosity recorded in M. Tempel's skilful drawings.

Comparison with future autographic pictures will quickly and easily settle the question of its variability. As yet there is little positive, though some presumptive, evidence for the affirmative. Hind's and Chacornac's admittedly variable nebulæ are situated not far off, one in the head, the other near the tip of the right horn, of Taurus. And it is unquestionable that some kinds of sidereal phenomena tend to localise themselves in certain quarters of the sky. There is, moreover, reason to believe that a nebula has vanished from the heart of the cluster itself. Such an object is marked on Jeaurat's chart of the Pleiades (published in 1782) in connection with a pair of small stars nnmbered by Bessel 31 and 32. These lie about half a lunar diameter north of Pleione, in a quarter where no vestige of nebulosity can now be distinguished; so that the possibility is excluded of Jeaurat's having merely anticipated subsequent discoveries. The stars 31 and 32 form a binary system already giving signs of mutual revolution; and one of them (No. 32) is considered by Lindemann as variable. If any weight attached to Jeaurat's estimates of brightness, there could be no doubt about the matter, since he stated them to be respectively of 7th and 4th magnitudes, while Bessel found them both of the 8th. Jeaurat's authority in photometry, it is true, is of the lowest; yet it is hard to believe that his eye can have represented to him a difference of three whole orders between two equal stars, visible side by side in one field of his telescope.

Stellar fluctuations have so frequently been observed to be associated with nebulous surroundings, that it is worth noting, as at least a coincidence, that neither Merope nor Maia is exempt from a strong suspicion of variability. The latter, according to M. Wolf, is slowly gaining lustre; the former oscillates through a range of one magnitude.

The stars of the Pleiades are immeasurably far off. None of them has any sensible parallax; and we are thus uninformed as to their intrinsic lustre, mutual distance, or gravitating mass. It is, however, easy to compute the dimensions of the group relatively to its remoteness from ourselves.[1] A circle described from Alcyone with a radius of 48′ includes all its principal stars. Only one of Bessel's 53 falls outside it. We may then take the globular mass of the cluster to be of this apparent size, disregarding the stellar streams external to it as being, more or less, outliers. Now, since the sine of an angle of 48′ is to radius as (in round numbers) 1 : 71, it follows that the furthest of the suns congregated into the nuclear group under consideration, are just 71 times as distant from us as from the centre of their own system. Consequently, Alcyone blazes upon them with 5000 times the lustre it displays to us, or as a star about 86 times the brilliancy of Sirius. It would still, however, seem a star rather than a sun. Even from the distance of Neptune, our own central luminary must outshine Alcyone, as viewed, say, from Atlas or Taygeta, fully 77,000 times.

The glimpse afforded by recent investigations of the structure of the Pleiades group is a very surprising one. We find in it a miniature sidereal system, the richness and variety of which bewilder theoretical conceptions, and recall, as analogous, the accumulated wonders of the Magellanic clouds. Nebulæ are discovered in most intimate connection with lucid stars, and in suspicious relations to their luminous vicissitudes, while themselves possibly subject to strange alternations of visibility. Stars of all orders are included in one vast assemblage, some doubtless magnificent orbs, of many times the radiance of our sun; others as inferior to them perhaps as the moons of Mars to Jupiter. The distribution of these bodies appears to be no less varied than their size. Groups are collected within the main group, systems revolve apart, the subordination of which to the laws of a general federative union leaves their internal liberty of movement unshackled. It is not, indeed, certain that a dynamical equilibrium of the whole subsists. Hints of a centrifugal tendency have been caught by M. Wolf, suggesting that an impulse of separation may at present be the predominating one. Possibly, then, Mr. Stone's curious observations on the slowly divergent proper motions of some southern stars, apparently the remnants of broken-up systems, may exemplify the inscrutable destinies in store for the unnumbered stars of the Pleiades.

A. M. CLERKE

NOTES

SCIENCE was *en fête* at the Mansion House on Tuesday night, when the Lord Mayor and Lady Mayoress received the Presidents and Members of Council of the Royal and other principal Learned Societies. Everything passed off in the most admirable way, and the presence of about 100 ladies, as well as of 200 of our representative men of science, made the gathering a very brilliant as well as a very remarkable one. The present

[1] As was done by the Rev. J. Michell in 1767 (*Phil. Trans.*, vol. lvii. p. 257).

Lord Mayor is entirely to be congratulated on this new departure.

On Monday last the galleries in the west wing of the British Museum, hitherto occupied by natural history objects which have been removed to South Kensington, were thrown open to the public. Besides a rare collection of objects of Oriental art, sacred and profane, the galleries are now the home of the ethnographical collections belonging to the British Museum, including the famous Christy Collection presented by the trustees to the nation. When Mr. Christy died in 1865 he left his prehistoric and ethnographical collections, together with a sum of money, to four trustees, with power to dispose of them to any existing institution, or to create an institution for them if this course should prove desirable. One portion of the collections had been arranged prior to Mr. Christy's death by Mr. Steinhauer of Copenhagen, and the trustees decided on offering this to the British Museum, together with a selection of objects of the same kind made from the remainder of the collections. This offer was accepted in 1866, but, owing to the crowded state of the National Collection, a temporary place of deposit was taken at 103, Victoria Street, formerly occupied by Mr. Christy. Here the scattered collections were brought together and incorporated with that arranged by Mr. Steinhauer; various additions were made from time to time during the past twenty years, either by presentation, or by purchase from the income arising from the sum left by Mr. Christy for the purpose of maintaining the collection. The ethnographical portion has now been removed to the British Museum, and is incorporated with the collections previously in the Museum. One provision of the gift by the trustees to the nation was that the collection should be actually placed in the British Museum, and exhibited there, and as this condition was not fulfilled until Monday last, it follows that it was only on and from that day that the Christy Ethnographical Collection became the national property. The prehistoric collection will, in like manner, be incorporated with the prehistoric collections already in the British Museum, and will shortly be arranged in the room between the top of the staircase and the ethnographical collection.

Of the new galleries and their contents it would be impossible to speak adequately here. They do not yield their secret in the course of a few cursory visits; each one of the many sections is a study in itself, and will engage the attention of the ethnologist and of the student of *Culturgeschichten*. The first room contains, on the left, the arms and armour of the civilised nations of Asia, from the Burgess, Meyrick, and Henderson collections, while the other side is occupied by the weapons and implements of the less civilised or barbarous Asiatic peoples; these come from Borneo, the Nicobars, Ceylon, the Khonds of Orissa, tribes inhabiting parts of Burmah and Northern Siam, the Nagas of Assam, the Ainos, and the tribes of Northern Asia. The second room is occupied by the utensils, weapons, implements, dress, &c., of Java, Sumatra, Australia, and New Guinea on the left; and on the right by those of Borneo, the Asiatic islands, Micronesia, and New Zealand. The last is an excellent collection, and one which it would be now very difficult, if not impossible, to collect again. The third room is devoted to the Pacific islands, to New Ireland, New Britain, the Solomon Islands, Fiji, the Harvey, Society, Friendly, Samoan, and Savage Islands. The centre of this room is occupied by two magnificent specimens of the canoes of the Solomon islanders. This room also contains the Sandwich Islands collection, which is now absolutely priceless, for it could never again be obtained. The fourth room is nearly wholly devoted to Africa, but the American collection (which appears to be greatly cramped for space) overflows into it. On the left we have South and West Africa represented, and North America; on the right we have the Marquesas and Easter Island, Madagascar, Eastern Central Africa, Abyssinia, North Africa, and Arctic America. The fifth and last room is possibly the most interesting and valuable of all. It is devoted to America. We commence on the left with the Ancient West Indies, which are mainly represented by stone implements; this is succeeded by a wonderful collection representing Ancient Mexico. Here also stone implements and pottery (especially the latter) abound; then come Central America and New Granada, and finally an invaluable collection representing the Inca civilisation of Ancient Peru. On the right of this room the collections from Modern Mexico, North-Western and Arctic America are placed. In this abounding wealth of ethnological objects it is difficult to specify one section which attracts the eye more than another. Each visitor, according to his tastes and course of study, will select for himself, but, as we have already suggested, the New Zealand, Sandwich Island, Ancient West Indian, Ancient Peruvian, and Ancient Mexican collections are probably unrivalled elsewhere in the world. When the prehistoric collections shall have been arranged, the British Museum will have at last materials for the illustration of the history of mankind worthy of the British nation.

We understand that Mr. John Smith, Curator of the Royal Gardens, Kew, has, in consequence of ill-health, resigned his appointment, which he has held for a period of twenty-two years.

A strongly supported memorial has been presented to the Lord President of the Council, urging the desirability of establishing a Medical Faculty and an Engineering School at Cardiff, in connection with the University College of South Wales. Forcible reasons are given for the establishment of the former in so thickly populated a region; and as several of the subjects required for medical students are already taught at Cardiff, it need not be difficult to supplement them, so as at least to carry medical studies to all but the final stage for the medical degree. As to an Engineering School, it is pointed out—that the engineering and colliery interests in the district are second to none in the world, while the rapidity of their growth has been unparalleled in our national history; that the urgent need for the establishment of a Faculty of Engineering in connection with the University College of South Wales and Monmouthshire is shown by the fact that no less than 90,000 skilled workmen are employed in the vast collieries, and in the iron, steel, tin, copper, chemical, and general engineering works of the district; that those who direct and manage the operations of these large industries (at a low estimate in number more than 4000 persons) must at present, in order to obtain a technical training, proceed to distant parts of the United Kingdom or to the Continent; so that for the great bulk of the people there are insuperable difficulties in the way of that higher education which is becoming more and more necessary in the face of the growing competition with Continental nations, and the greater advantages in the way of technical education offered by Germany, France, and other countries. It is to be hoped that Government will grant the prayer of the petition, and provide the funds necessary to establish the necessary Chairs.

It is intended to hold a Photographic Exhibition in Glasgow, in the Corporation Galleries of Art, during July, August, and September, 1886. The Exhibition will comprise:—(I.) Illustrations of the history of photography, early daguerreotypes, calotypes, &c.; (II.) photographic instruments, materials and appliances, lenses, cameras, chemicals, &c.; (III.) illustrations of modern processes in photography; (IV.) applications of photography: portraiture, landscape photographs, architecture, reproductions of pictures, drawings, etchings, and engravings, photolithographs, photogravures, copying plans, maps, mechanical drawings, illustration of books, decoration of glass, pottery, &c., astronomy, meteorology, microscopy, &c. The object of the Exhibition is to illustrate the history and development of photography, and to show the numerous and important applications of the art to science, art, and industry. All objects selected for exhibition will be chosen with the view of promoting the educational value of the collection. The elements of competition and trade will not enter into the Exhibition, nor will there be any prize offered to exhibitors. Portraits will be shown only in so far as they may serve to illustrate the various methods of portrait photography, or special features of size, treatment, &c. Landscapes may be accepted on account of the interest of the subject, as well as for technical excellence. Reproductions of art objects will be received both as illustrations of processes and for the artistic interest and importance they possess. Communications respecting the business of the Exhibition should be addressed to the Secretary of the Museum and Galleries Committee, Town Council, Glasgow.

Mr. George R. Rogerson, an old pupil of the College, has presented his valuable astronomical observatory to the Council of Liverpool College. The instruments include an equatorially-mounted refracting telescope, a spectroscope with ten prisms, a micrometer, and also an astronomical library.

An important essay on micro-chemical reactions has just been published in Brussels by MM. Klement and Renard. Availing themselves of the published researches of Boricky, Behrens, Streng, Lehmann, Haushofer, and others, combined with the results of their own extensive researches, the authors have produced the most complete account of the subject which has yet appeared. They describe the methods of research and the reactions, simple and characteristic, by which compounds of more than fifty elementary bodies may be identified in minute crystals recognisable under the microscope. They also give a brief description of the processes of isolation and identification applicable to such compounds as the mineral constituents of rocks. The value of the treatise is much enhanced by the accompanying plates, eight in number, comprising nearly 100 figures of the forms of crystals obtained by the various reactions described in the text.

An International Congress of Climatologists and Hydrologists is appointed to meet at Biarritz during the first week in October. The co-operation of the various medical, hydrological, and meteorological societies of France has been received; the Minister of Commerce will open the first meeting on October 1, and Dr. Durand-Fardel of Paris will be the President. The object of the Congress will be to assemble specialists from every country to discuss questions connected with hydrology and climatology. Excursions are to be made to various watering-places in the Pyrenees.

The sale of a considerable portion of the celebrated Godeffroy Ethnological Collection from the South Sea Islands, at Hamburg, to the Leipzig Museum, has already been recorded. The portion thus sold appears to have been mortgaged by the owner, and the sale was made by the mortgagees. The remaining part, which was not mortgaged, and which included very valuable zoological and palæontological collections, as well as a comprehensive collection of woods from the South Seas, has just been purchased by the city of Hamburg for 85,000 marks.

Mrs. Ogilvie, of Sizewell House, has presented 1300*l*. to the Ipswich Museum, to clear off the debt attaching to the building.

The Municipal Council of Paris at its sitting of the 29th ult. resolved to vote a sum of 5000 francs to M. Georges Poucher, to enable him to continue his investigations into the course of the Gulf Stream.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mrs. Carter; a Black-eared Marmoset (*Hapale penicillata*) from South-East Brazil, presented by Mr. A. Evershed; two Three-toed Sloths (*Bradypus tridactylus*) from British Guiana, presented by Capt. Hicks; a Crested Porcupine (*Hystrix cristata*) from Ceylon, presented by Miss C. S. Simpson; a Crested Porcupine (*Hystrix cristata*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. John Hewat; an Indian Antelope (*Antilope cervicapra*) from India, presented by Capt. J. C. Robinson; a Herring Gull (*Larus argentatus*), British, presented by Capt. H. G. Alexander; a Ceylonese Hanging Parrakeet (*Loriculus asiaticus*) from Ceylon, presented by Mr. C. W. Rosset; a Clouded Tiger (*Felis macrocelis*) from Assam, a Burchell's Zebra (*Equus burchelli* ♂) from South Africa, two Globose Curassows (*Crax globicera* ♀ ♀) from Central America, deposited; two Black-footed Penguins (*Spheniscus demersus*) from South Africa, purchased; a Lesser Koodoo (*Strepsiceros imberbis* ♂) from Somali Land, a Ruddy Sheldrake (*Tadorna casarca*), European, received in exchange; two Black-backed Jackals (*Canis mesomelas*), an Eland (*Oreas canna* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Parallax of Nova Andromedæ.—Prof. Asaph Hall, writing under date February 12, in the *American Journal of Science*, states that this star was then very near the limit of visibility in the great refractor of the Washington Observatory. It had thus in five months faded down from "the limit of visibility to the naked eye to that in a 26-inch telescope." Led by the suggestion of Prof. Peters that it would be interesting to test the parallax of such a star, Prof. Hall began on September 29 a series of measures of the Nova, referring it by means of polar co-ordinates to a known star of the eleventh magnitude, distant from it a little less than 2′. The measures do not, in Prof. Hall's opinion, show any proof of a parallax, though they indicate perhaps a diminution of the apparent distance from the comparison star. The variation in the brightness of the star would, however, be likely to affect the measures. The star was too faint for the measures to be continued after February 7.

Prof. Hall mentions favourably Mr. W. H. Monck's suggestion (*Observatory*, vol. viii. p. 335) that the Nova may have been a swiftly-moving star "that in rushing through the nebula had been set on fire like a meteor in our atmosphere."

M. Lœwy's Method of Determining the Elements of Refraction.—Mr. Gill, writing on the subject of M. Lœwy's proposal to determine the elements of refraction by means of a reflecting prism placed in front of the object-glass of an equatorial (Nature, vol. xxxiii. p. 303), whilst expressing his appreciation of the merits of the French *savant's* scheme, suggests that, in place of having the tube of the telescope fixed and the prism movable with respect to it, it would be better to have the prism rigidly attached to the objective, the micrometer threads being parallel to the line of intersection of the reflecting surfaces of the prism, and the whole tube capable of rotation round its axis. By this arrangement a sufficiently firm connection would be established between the prism and the micrometer, and the necessity of calculating the direction of the line of measurement by the latter would be entirely obviated. It is also pointed out by Mr. Gill that the carrying out of M. Lœwy's plan necessitates the construction of a complete special apparatus, but that it would be comparatively easy to adapt the modern heliometer to this kind of observation. It would only be necessary to mount the prism symmetrically in front of the object-glass, so that the line of intersection of the reflecting surfaces should be at right angles to the line of section of the object-glass, and to the axis of the heliometer. The observations would then be made by bringing the images of the two stars into coincidence near the centre of the field by symmetrical movements of the segments of the objective, as in the ordinary process of measurement with this instrument. This method of observation is, in Mr. Gill's opinion, the most convenient and the most accurate of all those known at the present time, and the advantage of precisely simultaneous measures is a point of considerable importance when one of the stars is at a low altitude which is rapidly varying.

DISCOVERY OF MINOR PLANETS.—Four new minor planets were discovered in less than a week by Herr Palisa at the Vienna Observatory—Nos. 254 and 255 on March 31, No. 256 on April 3, and No. 257 on April 5. All are about the thirteenth magnitude.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *APRIL* 18-24

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 18

Sun rises, 5h. 0m. ; souths, 11h. 59m. 16·8s. ; sets, 18h. 59m. ; decl. on meridian, 10° 54′ N. : Sidereal Time at Sunset, 8h. 46m.

Moon (Full) rises, 18h. 58m. ; souths, 0h. 24m.*; sets, 5h. 42m.*; decl. on meridian, 9° 13′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 34	11 4	17 34	5 11 N.
Venus	3 36	9 9	14 42	6 5 S.
Mars	13 43	20 47	3 51*	11 42 N.
Jupiter	15 51	22 7	4 23*	2 19 N.
Saturn	8 16	16 28	0 40*	22 51 N.

* Indicates that the southing or setting is that of the following morning.

Occultation of Star by the Moon (visible at Greenwich)

April	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
18	κ Virginis	4½	21 5	21 48	349 273

April	h.	
18	6	Mars stationary.
21	14	Mercury stationary.

Places of Comet Fabry.

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 18	0 13 47	37 53 N.	9·628	145
22	0 58 58	33 58	9·504	230

Places of Comet Barnard.

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 18	1 43 58	37 41 N.	0·109	37
22	1 41 36	39 2	0·075	54

The comet places are for Berlin midnight.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
S Cancri	8 37·4	19 27 N.	Apr. 23,	23 41	*m*
R Leonis	9 41·4	11 57 N.	,, 23,		*m*
U Virginis	12 45·3	6 10 N.	,, 24,		*M*
W Virginis	13 20·2	2 47 S.	,, 18,	0 0	*M*
δ Libræ	14 54·9	8 4 S.	,, 18,	3 52	*m*
U Coronæ	15 13·6	32 4 N.	,, 23,	4 10	*m*
S Libræ	15 14·9	19 59 S.	,, 22,		*m*
S Ophiuchi	16 27·7	16 55 S.	,, 19,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 18,	8 30	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Apr. 21,	2 20	*m*
			,, 24,	0 0	*M*
δ Cephei	22 24·9	57 50 N.	,, 24,	0 0	*m*

M signifies maximum ; *m* minimum.

Meteor Showers

The present week is one usually rich in meteors, but moonlight will interfere with observation this year. The most interesting shower, the *Lyrids,* radiant R.A. 274°, Decl. 34° N., April 18–20, has been poorly represented of late years. Several radiants from Cygnus and Draco are usually active from April 19 to April 23.

GEOGRAPHICAL NOTES

THE greater part of the contents of the current number of *Petermann's Mittheilungen* is devoted to the geography of the African continent. In the first paper (which is accompanied by an excellent map) Dr. Chavanne describes his journey from the Lower Congo to San Salvador and the Arthington Falls, as well as other explorations in Portuguese West Africa. The position of many hitherto unsettled points is now defined. The traveller states that he paid particular attention to the question of the population and its density. He counted the huts in the places through which he passed, and endeavoured to obtain from the natives details of the houses within 5 kilometres on each side of his route, and he comes to the conclusion that the estimates of some previous travellers are greatly exaggerated. Dr. Lenz communicates some observations on the Congo, and Prof. Kirchhoff writes a short but important article on the hydrography of the Muta Nsige. Dr. Karl Lechner gives the history and present condition of what he styles a "language island" in Moravia, a kind of oasis in this province of Slavs, in which the German, or a kind of German, language has been preserved by the people for centuries. The place is Wischau, not far off the high road between Brün and Olmütz. The people call themselves Schwoben, and in the struggle for the maintenance of their nationality they have been assisted by the Tyrol and Bavaria. Dr. Müller defends his edition of the Arabian geography of Hamdânî against the strictures of Herr Glaser in his recent account of his Arabian journeys.

THE *Verhandlungen* (Bd. xiii. No. 3) of the Geographical Society of Berlin contains an account by Lieut. François, of his journeys in the southern basin of the Congo. He accompanied the Wissmann Expedition to Kassai, and also Mr. Grenfell on his journey on the Lulongo and Chuapa, and he describes some of the incidents and observations of these journeys. Dr. Moritz, who proceeded to Syria in 1884, on behalf of the Archæological Institute of Berlin, read a paper on the geographical experiences of his journey. A brief communication from Dr. Sievers recounting his work in Columbia is also published.

THE Foreign Department of the Würtemberg Government has invited the Governments of Austria, Bavaria, Baden, and Switzerland to join in a common and simultaneous investigation of the depths of Lake Constance, and the preparation of a chart of it. The proposition is that a commission of specialists from all these States should meet at Friedrichshafen to settle the extent, methods, and time for the investigation. The Swiss Assembly has welcomed the proposal, more especially as the Swiss have already carried out a considerable part of the work as far as their portion of the trade is concerned.

SOME time since we noticed the success of two officers of the French navy, Capt. Réveillère and Lieut. Fesigny in a daring attempt to ascend the rapids of the Meikong when the river was in full flood. The Colonial Council of Cochin China has now passed a resolution affirming the necessity for organising a mission of engineers or naval officers to enter into a complete and minute study of the Meikong rapids at low water. These rapids are all that prevent access from the sea by the Meikong to Hung-Tseng, Luang-Prabang, and beyond even to Kiang-hung and the Shan States up to the Chinese border.

FURTHER details of Mr. Charles Winnecke's plan of that part of South Australia crossed by the overland telegraph, to which we have already referred, are supplied in a late issue of the *Colonies and India.* The survey shows that the distance from Tennant's Creek eastwards over the rivers Buchanan, Rankine, James, Herbert, and Milne, is 1626 miles. The country continually rises from Port Augustus till Burt Plain on the MacDonnell ranges—a distance of 1000 miles—is reached, after which it falls gradually to the boundary. Mr. Winnecke has included in his plan every camping-place along the telegraph line. He asserts that Lake Eyre is a considerable depth below the sea-level, a statement which he made in 1877, but which has been disputed. The highest point along the route was the Burt Plains in the MacDonnell ranges, which are 2532 feet above the sea-level, but the ranges themselves are several thousand feet higher. The telegraph station of Central Australia, Alice Springs, is 2000 feet above the level of the sea. The Finke River is described as the largest and most important in Central Australia; its southern part is now being re-explored by Mr. Lindsay. On the whole it appears that Mr. Winnecke's map and the details accompanying it add considerably to our knowledge of the geography of Central Australia.

THE last census of the Hawaiian Archipelago, as compared with that of 1878, gives some curious results. In these six years the pure natives have decreased from 44,088 to 40,014, while the half-castes have increased from 3420 to 4218. The Chinese immigrants in 1878 numbered only 5916; in 1884 they had increased threefold, their number being 17,931. In every other respect the population increased. The Portuguese labourers number 9377 against 436; immigrants from the United States were 2066 against 1276; British subjects 1282 against 883; Germans 1600 against 272, and so on. The children born in the archipelago of foreign parents increased from 947 in 1878 to 2040 in 1884. On the whole the population was 80,578 in the latter year, against 57,985 in the former, although the natives had diminished about 10 per cent. in the six years. We thus havd passing under our eyes the peaceful extinction of a race by the operation apparently of natural laws. The Hawaiians govern themselves under a sovereign of their own race, and under their native conditions; yet they are rapidly disappearing, simply through the presence of other races, without war or any other of the direct causes to which the decay of native races is generally attributed. The social conditions of the archipelago are an interesting study just now from many points of view.

M. VAN GEÛNS, Chief Engineer and Inspector of Public Works in Java, has lately been on a journey through that and the neighbouring islands, of which he has published an account. He speaks of the various Javan volcanoes, of which much has been heard lately, and says that since the eruption of Krakatão in 1883 the people live in comparative quiet. But this calm is only apparent, for volcanic eruptions, always numerous, are incessant. The volcanoes on the Island of Java itself manifest everywhere great activity, but not so as to produce a serious cataclysm. Smeroc, which is the highest mountain in the island, and its neighbours Brômo and Lamonyon, are active from time to time. In 1885, for example, Smeroc overwhelmed plantations and villages on its side with eruptive matter. Merapi, in the centre of the island, shows constant signs of life; lava is constantly flowing from it, smoke and steam are almost always visible at its summit, so that it is one of the active volcanes of the world. M. van Geûns reports another curious phenomenon. After a period of extreme drought continued rains have inundated one part of the country, while there is an absolute want of water in other places which should have it in abundance. This anomaly is attributed to the monsoons which blow irregularly, and which cause more anxiety to the Javanese than their volcanoes.

THE MINES COMMISSION REPORT

THE final report of the Accidents in Mines Commission has been issued as a Blue Book. The report, which occupies 120 pages, is accompanied by minutes of the evidence taken and numerous appendixes and diagrams. The report concludes with the following paragraphs, in which the Commissioners give a summary of the most important subjects dealt with and of the chief conclusions and recommendations based upon them:—

Volumes of air sufficient for the ventilation of even the most extensive collieries are capable of being passed through the workings by means of properly constructed furnaces, or by mechanical contrivances, such as are already in action at most of the collieries. At a large number of collieries the sectional area of the intake and return-air courses may be increased with advantage. Where furnaces are used they should by preference be in connection with dry and deep shafts, and should be provided with dumb drifts. Where mechanical contrivances are employed they should be in such positions and placed under such conditions as will tend to insure their being uninjured by an explosion, and, if they are not provided altogether in duplicate, there should be at least an engine in reserve. The improved system of ventilation by "splits" and the shortening of the air-courses, as practised in the larger collieries, is a subject of great importance, and we recommend that more general attention should be given to it. It would conduce greatly to safety if the system of carrying the intake air through two parallel drifts, of which one may be used as the travelling road, were introduced into workings likely to become extensive, and where mechanical haulage is intended to be employed.

That the casualties due to falls of the roof and sides are much more numerous than those due to any other causes is demonstrated by the tabular statement given at the commencement of this report. It is essential that all the officials and workmen in mines should pay special attention to the careful propping of the working places and travelling roads. In the north of England the system of trusting mainly to officials (deputies) for the timbering is found to answer well; in South Wales and other districts, where the roof, face, and sides are more liable to falls, the system of the men timbering their own working places has been found to be best.

We are of opinion, however, that in all cases the security of the working places should be examined into by over-lookers once at least in the course of each shift. Supervision has been greatly enlarged in the last thirty-five years, and we find that there is generally one official so employed to about twenty men, sometimes one even to eleven or twelve men. In order to reduce the number of casualties from falls, we recommend the observance of the following:—(*a*) The maintenance of ample supplies of timber in localities convenient to the workmen; (*b*) the proper training of each miner to the best modes of timbering and of otherwise protecting his working place; (*c*) the exercise of increased care on the part of the workmen in watching the roof, sides, and face, and protecting themselves in time; (*d*) the introduction, as far as possible, of arrangements with the workmen which will make it their interest not to avoid the labour of putting up the necessary timber, cog-walls, buildings, or nogs for their proper protection; (*e*) the employment of special timbermen or deputies for the timbering of main ways and also for the repairing as well as drawing of timber; (*f*) preventing timber being left in the goaf of long wall workings, which would have the effect of breaking the roof; (*g*) driving the working places as rapidly as possible by shifts of an ample number of workmen in each face, and so reducing the risk of falls and exposing the least number of men to danger at any one time.

We are of opinion that by improved discipline and the exercise of greater care by those employed in or travelling through engine planes and other roadways the number of casualties comprised under the head of "miscellaneous accidents" would be considerably diminished. The practice in some collieries in South Wales of boys running in front of the horses and trams should be prohibited. The very numerous casualties under the heads of "falls of roof and sides" and "miscellaneous accidents" are due in great part either to carelessness or want of early training. Looking to the importance of practical training, and of encouraging boys to enter the mines at the ages specified by the Mines Regulation Acts, we are of opinion that careful consideration should be given to this point in connection with the administration of the Elementary Education Act.

We think that the experiments we have made on the pressure of fire-damp in plugged bore holes in coal, a pressure sometimes amounting to upwards of 400 lbs. on the square inch, have thrown much light upon the occurrence of sudden outbursts of gas. The boring of holes upward or downward has been successfully tried as a means of avoiding such outbursts, and we have little doubt that the closer attention which is now paid to thorough stowing and packing or building in the workings will contribute greatly to the same end. It is almost impossible to account for many of the accidents which have occurred in well-managed mines, some of which have originated in the main-intake airways, except upon the supposition that gas has suddenly invaded the workings from the adjacent strata. Sudden outbursts of large quantities of gas, accompanied by violent disruption of the floor, roof, or coal, are fortunately rare, but smaller incursions of gas, accompanied by falls of roof, or even without any apparent displacement of ground, are comparatively frequent. We are of opinion that in working fiery seams at great depth such abnormal discharges of gas must occasionally occur, yet that they may be successfully met by ample ventilation, good discipline, and efficient lamps. While we recognise that variations of atmospheric pressure exert an influence on the escape of gases which have accumulated in cavities, and possibly to a slight extent on that of gases emitted directly from the coal, we entertain great doubt as to the wisdom of placing reliance on the issue of meteorological warnings. These can at best only convey very imperfect information, which, moreover, may be sometimes dangerously misleading. We are of opinion that safety would be much more likely to be insured by unceasing vigilance on the part of the officials and workmen in the mine than by any attention to such warnings.

The action and effects of coal-dust in connection with mine explosions have been made the subject of careful study and comprehensive experiment by numerous workers since attention was first drawn, about forty-two years ago, by Faraday and Lyell to the functions exercised by coal-dust in "aggravating and extending the injurious effects of fire-damp explosions." The results and conclusions which have been arrived at in this direction, and to which the labours of your Commissioners have contributed, are sufficiently complete and definite to warrant the following authoritative statements:—The disastrous effects of fire-damp explosions in coal-mines are almost always aggravated and extended by the existence of coal-dust in dry mine-workings and roadways. A gas explosion in a dry mine, even if only of comparatively trifling nature, will raise and inflame coal-dust existing at the seat of the explosion or in the vicinity; the flame attending the explosion will be thereby increased and carried to more or less considerable distances, and may thus become communicated to any accumulations of explosive gas-mixture which may exist in goaves or other lurking places at a distance from the seat of the original gas explosion.

The firing of an explosive in shot-hole of a strength which is in excess of the power applied, or which has not been sufficiently tamped, will result in the almost complete projection of the highly-heated products of explosion and of a more or less considerable body of flame from the mouth of the hole, as from the bore of a gun; it thus produces what is known as a blown-out shot. And further, if the charge of explosive is decidedly greater than that necessary to perform the desired work in the coal or stone where it is applied, a more or less considerable projection of highly-heated products of explosion will also take place, and effects similar to those of a blown-out shot will be produced. The production of a blown-out powder shot in a mine-working, in the entire absence of coal-dust, or in a wet mine, is not attended by the projection of flame to a very considerable distance, but the flame thus projected is much increased in volume if, as is frequently the practice, dry or slightly damp small coal has been used as stemming for the shot. If a blown-out powder-shot be produced in a dry locality where coal-dust exists in more or less abundance, the flame projected by the shot is sure to be considerably increased and extended by the ignition of portions of the dust-cloud which is raised by the rush of air occasioned by the firing of the shot. A result of this nature will be produced even if the air in the vicinity of the blown-out shot is entirely free from fire-damp. Unless the coal-dust which exists in the immediate vicinity of a blown-out powder-shot is dry, very finely-divided, and of a very highly inflammable character, the propagation of flame from the shot by the raised dust will only take place to a comparatively limited extent if the atmosphere in which the dust is raised be entirely free from fire-damp. It is, however, well established that, even when the air is quite free from fire-damp, an exceptionally inflammable coal-dust, in a very finely divided and dry condition and existing in abundance in the immediate vicinity of a blown-out shot, may, when raised by the shot, be ignited so readily, and carry on the flame so rapidly, that it may produce explosive effects of a similar character to those caused by a gas explosion. The flame, as it rushes along, if fed by freshly raised dust, may extend under these circumstances to very considerable distances, with results resembling, in their disastrous nature, those of explosions originating with, and mainly due to, fire-damp. If a blown-out powder-shot occurs in a locality where the atmosphere contains a small proportion of fire-damp (even not above two parts in 100 of the air), the presence of dry, fine, and porous dust, even if it be only comparatively slightly inflammable, may give rise to the explosive propagation of flame to distant localities, where either accumulations of inflammable or explosive gas-mixture (as in goaves or old working places), or deposits of very inflammable dust, may take up the explosion and still further extend its disastrous effects. Wherever a coal is worked which contains inflammable gas, the atmosphere in the vicinity of the workings, however efficient the ventilating arrangements, will at one time or another, and, it may even be said, generally, contain some small proportion of fire-damp. Mines have hitherto been considered free from fire-damp when the search for gas by means of a lamp flame has been unattended by the appearance of a cap upon the flame or by an elongation of the flame. This test, however, fails to indicate the presence of fire-damp, if the atmosphere contains less than from 2 to 2·5 per cent. of its volume of marsh gas. Such a slight contamination of the atmosphere by fire-damp is not only sufficient to greatly enhance the dangers due to the existence of dust in any abundance in a dry mine-working, as already described, but is also sufficient actually to give rise to the production of an explosive mixture with dust raised in it by a blown-out shot. Small proportions of gas, such as are referred to, when existing in the atmosphere of a mine, can now be detected by more delicate gas-indicators than a lamp flame; but, while a knowledge is thus afforded of the presence of gas, it remains impracticable to prevent such slight contamination by fire-damp of the air of a mine near the working places.

It will be seen from the foregoing that such contamination, although quite insufficient to constitute in itself a source of danger, does become dangerous if dust co-exists with it, in abundance, in dry mine-workings, if powder-shots are fired in such workings. No means are at present known by which security can be attained against blown-out shots during blasting in hard coal or in stone, and the use of powder in coal is sometimes attended by the emission of flame, even when blown-out shots are not produced. It follows from the foregoing that the firing of powder-shots in a dry mine-working where dust exists in abundance must always be liable to be attended with disastrous results if the air in such a locality is contaminated by fire-damp, even to so small an extent as in the proportion of two volumes in 100 volumes of the air of the mine. The constant removal of accumulating dust from the workings in dry mines, to such an extent as to guard against the raising of any considerable quantity of dust where shots are fired, could scarcely be so thoroughly carried out, in any but very exceptional cases, as to constitute by itself an effectual precaution. The application of water to the laying of dust in roadways has been applied here and there with some amount of success, but the effective adoption of such a measure in or near the working places is in some instances attended with practical difficulties. Unless very copious watering be resorted to, it would be ineffectual in guarding against the dangers arising from the firing of powder-shots in dry and dusty workings where the air may contain some small proportion of fire-damp. The employment of hygroscopic or deliquescent salts in conjunction with water has not been found a trustworthy means of maintaining dust in a safely moist condition. The dangers which attend the firing of powder-shots in dry mine workings where dust exists in abundance, and where the air may contain even only a small proportion of fire-damp, can therefore not, with our existing knowledge, be effectually guarded against, except by combining the removal of dust as far as practicable with very copious watering. The obvious inference to be drawn from the foregoing is that a due regard for the safety of those employed in mines, where the conditions above indicated prevail, precludes the use of powder, unless the precautions just specified are effectually applied. The results of extensive practical experiments, carried out by ourselves and by others, have demonstrated that the abolition of the use of powder, where the conditions above indicated prevail, will not generally involve any formidable inconvenience, because the work which is accomplished by its employment, both in coal and in stone, can now be performed with equal efficiency and at very little, if any, greater outlay, by one or other of the following available alternative means:—(*a*) In some coal-seams the lime-cartridge will perform work quite equal to that accomplished with powder, at no greater cost, and with absolute immunity from risk of explosions; (*b*) mechanical appliances exist which will do efficient work, not only in some kinds of coal, but also in some stone or shale over or underlying coal; (*c*) the so-called "high" or violent explosive agents, which are represented by dynamite or gelatine-dynamite, and by gun-cotton or tonite, can now be applied, not only for working economically in stone or shale, but also for coal-getting, by using them in conjunction with water, according to one or other of the methods described in this report.

The "high" explosives may be used, as indicated in (*c*), with security against the ignition of coal-dust thickly suspended in air, by a blown-out shot or by the effects of an over-charged hole, even when the air contains some small proportion of fire-damp. One very simple method of using the "high" explosives in conjunction with water, included in (*c*), which may be supplemented by the use of ordinary tamping for securing the best working results, has, so far as several severe tests have shown, afforded a complete safeguard even against the ignition of an explosive mixture of fire-damp and air by a blown-out shot, Therefore, in dry mine-workings, where the removal of dust, combined with copious watering cannot be carried out, and where neither of the alternative methods (*a*) and (*b*) of working in coal or stone can be advantageously substituted for blasting by means of powder, in localities where fire-damp is liable to have access to the mine-workings, shot-firing may be safely carried on, provided that any one of the "high" or violent explosives is employed, in one or other of the modes described, in substitution for powder. But the methods of operation which furnish effective safeguards when applied in conjunction with the high explosives fail to furnish such safeguard when applied in the same way together with powder. Unless, therefore, effective measures be adopted for the removal of dust as completely as practicable in the vicinity of the place where the shot is to be fired, such removal being followed by copious watering, the employment of powder, or of any explosive preparation of a similar nature to powder, should be prohibited in dry coal-mines where fire-damp may pervade the air, and where at the same time coal-dust accumulations are unavoidable.

With the view of promoting security from accidents under circumstances where blasting may be practised in coal-mines we would recommend that the following instructions be observed:—(1) That all work involving blasting in mines should be intrusted only to experienced workmen. (2) That, in order to lessen the risk from blown-out shots, particular care should be taken that each shot should be assisted by under-cutting and nicking or shearing whenever it is practicable. (3) That the tamping, stemming, or ramming should consist of very damp or non-inflammable material. (4) That where strong tamping is needed the compression of air at the bottom of the hole should be avoided by pushing in the first part of the tamping in small portions. (5) That where safety-lamps are used and powder is employed the shots should be fired only by specially-appointed shot-men, who before firing the shots shall satisfy themselves that the foregoing instructions are observed, and shall also satisfy themselves by carefully examining all accessible contiguous places within a radius of twenty yards of the shots to be fired that fire-damp does not exist to a dangerous extent.

The employment of the ordinary miner's fuse, which when burning is liable to allow fire to escape from its extremity or laterally into the atmosphere, should not be permitted in any mine-workings where the exigencies of safety dictate the exclusion of powder and the substitution for it of one or other of the "high" explosives in conjunction with water. Similarly, no description of mining fuse, however safe in itself, should be allowed to be ignited in such localities by means either of a lamp-flame or of a wire which has been made red hot by inserting it into the gauze of a safety-lamp, or by means of any other source of fire, which, when applied to the lighting of the fuse, must come into contact with the atmosphere of the mine. Electrical exploding appliances present very important advantages from the point of view of safety over any kind of fuse which has to be ignited by the application of flame to its exposed extremity, as the firing of shots by their means is not only accomplished out of contact with air, but is also under most complete control up to the moment of firing. Their simplicity and certainty of action have been much increased of late years while their cost has been greatly reduced, and but little instruction is now needed to insure their efficient employment by persons of average intelligence. For the foregoing reasons the use of electrical arrangements for firing shots in mines, where the employment of powder for blasting is inadmissible, should be encouraged as much as possible. Where the regular use of electrical exploding appliances is attended with serious difficulties, as in wet mines, a special form of miner's fuse, now procurable at a cost very slightly, if at all, greater than that of the ordinary miner's fuse, and exempt from the defect of a possible lateral escape of fire, should be employed, but it should be used only in conjunction with a special self-contained igniting arrangement. Such an appliance should be constructed to fit over the entire exposed end of the fuse in a shot-hole, and to ignite the fuse out of contact with the air, and after the lapse of a definite interval (*i.e.* five minutes) from the time when it has been set into action by the person in charge of the shot-firing. Simple, cheap, and efficient forms of "igniter" have been devised which fulfil these conditions.

It has been shown that mines which have hitherto been considered free from fire-damp may have the air which passes through them vitiated to an extent corresponding to about 2 per cent. of its volume of marsh gas. The air in many such mines may probably never be entirely free from explosive gas, at all events in the neighbourhood of freshly cut faces of coal and in the return airways. It has been demonstrated in our experiments that when the atmosphere contains 5 to 5·5 per cent. of marsh gas it becomes highly explosive. We have even obtained explosions which, though less violent, might be nevertheless destructive of life if they occurred on the large scale possible in a mine when the air contained only 4 per cent. of marsh gas. It will thus be seen that air which would appear free from gas if tested in the ordinary way may become by the addition of only about 2 per cent. of marsh gas capable of propagating flame and causing destruction, while the addition of about 3 per cent. converts it into a highly explosive mixture. As we have already pointed out, air which would appear quite free from gas if examined by a lamp flame may become explosive when laden with fine, dry coal-dust. It has been stated that appliances now exist by which very small proportions of marsh gas in air may be readily detected, and which can be used for examining the atmosphere of a mine. With Liveing's indicator present, gas in the air can be estimated with sufficient accuracy for all practical purposes, even when the proportion is as low as 0·25 per cent. Maurice's indicator is also capable of giving accurate measures of the proportion of gas, and is very portable, but the time required in taking an observation with the instrument in its present form seems to preclude its practical application.

The natural inference from the foregoing is that some mines hitherto considered safe with naked lights may at times be in peril. It may be that risks of explosion, arising out of the possibility of an unforeseen contamination of the air by fire-damp to a dangerous extent in parts of the workings of some coal-mines, can only be provided against by the invariable use of safety-lamps. We have not, however, considered it advisable to make a suggestion of this nature, because the great preponderance of casualties due to falls of stone and coal, over those arising from explosions, points to the importance of miners having the advantage of superior illumination afforded by naked lights in comparison with even the best forms of safety-lamp, when the circumstances of the mine, in regard to association of fire-damp and coal-dust, do not necessitate the use of safety-lamps.

We have therefore arrived at the following conclusions:—(1) That it is most important that all mines should be carefully examined by means of indicators capable of detecting as small a proportion as 1 per cent. of gas; such examination to be made before the commencement of each day-shift, and, in case of an interval, also before the succeeding shift. (2) That in all dry mines where the air may be laden with coal-dust, and where fire-damp is either known to be given off from the strata, or may from experience be reasonably suspected to exist, the Secretary of State may require safety-lamps to be used, unless the owners and workmen of such mines prove, to the satisfaction of a court of arbitration to be appointed by the respective parties, that less liability to accidents, generally, will be involved by the working of the mine with open lights than by the use of safety-lamps. It should be a special instruction to such court that the circumstances of each mine be taken into consideration with reference to the following points: (*a*), the mode of working; (*b*), the nature of the coal-seams and of the roofs and floors of the seams and of the adjacent strata; (*c*), the proximity of the seams to each other; (*d*), the emission of gas from the seam, and the liability to blowers or outbursts of gas from the coal, roof, or floor; (*e*), the order of working the seams of coal. For the system which prevails in some places of working with mixed lights—that is, with open lights and safety-lamps intermixed in the same set of workings—there is no justification, and this practice should be strictly prohibited. We are of opinion that in mines where safety-lamps are required, the position of lamp stations, or places where open lights are allowed, in reference to the possibility of access of vitiated air, should receive much more attention than at present. It is desirable that, at convenient places near the working faces, reserves of lighted and locked lamps be kept available for exchange with those extinguished in the workings.

It has long been known that if the atmosphere become inflammable the Davy and Clanny lamps, and in a less degree the Stephenson lamp, are unsafe in currents having velocities much below those encountered in well ventilated mines. Our experiments fully confirm this. The ordinary Davy lamp becomes unsafe before a velocity of 400 ft. per minute is attained. The ordinary Clanny lamp will almost certainly cause an explosion in a current having a velocity of 600 ft. per minute. A Stephenson lamp will frequently cause an explosion in a current with a velocity of 800 ft. per minute. From the information supplied to us by your Majesty's Inspectors of Mines and others, currents having velocities of more than 400 ft. per minute are now frequently found in working places. The currents sweeping long wall-faces have very often higher velocities, in main airways current-velocities approaching 2,000 ft. per minute are recorded, and considerably higher velocities are encountered at regulators and in narrow places, or when large falls occur. It is thus obvious that, in the present improved ventilation of collieries, ordinary Davy and Clanny lamps have ceased to afford protection from explosion, and that the Stephenson lamp, though more secure than the two former, cannot be relied upon. We felt it our duty at an early stage of our investigation to draw the attention of the Secretary of State to the danger attending the use of the ordinary Davy and Clanny lamps, and our subsequent experiments have made this danger still more conspicuous. We have no hesitation in stating that these lamps should be prohibited, unless they are inclosed in cases capable of effectually preventing the gauze from being exposed to the full force of the current of air. Many lamps now exist which are able to resist, in highly explosive atmospheres, current velocities up to and even exceeding 3000 ft. per minute, at all events for several minutes. Ample time is thus obtained for bringing into operation a "shut off" appliance for the extinction of flame produced both by the illuminant and by ignited gas within the lamp. We consider that all safety-lamps should be provided with such an appliance.

Four lamps seem to us deserving of special attention, as combining a high degree of security with fair illuminating power and simplicity of construction. They are Gray's lamp, Marsaut's lamp, the bonneted Mueseler lamp, and Evan Thomas's modification of the bonneted Clanny lamp, described as No. 7 in our report. In our experiments the last lamp has given upon the whole the best results. It will be seen, however, from our experiments that many other lamps exist which are simple in construction, and almost, if not quite, as safe as the above. They generally, however, yield an inferior light in consequence of the flame being surrounded by gauze, but from this method of construction they derive the advantage of not being entirely dependent on glass for their security. To make a particular lamp compulsory would be unwise, as calculated to throw difficulties in the way of introducing improvements which will no doubt arise in the future, but we think it desirable that some control should be exercised in reference to the description of lamps employed in coal-mines, and that only those lamps should be used which are authorised from time to time by the Secretary of State. A lamp may be of the safest pattern and yet small defects in the fitting of its parts may entirely deprive it of its power of affording protection. In preparing a large number of lamps for use in a mine it may happen, even with the greatest care on the part of the lamp-men, that a lamp in an imperfect condition may be allowed to pass. The detection of these imperfections by simple inspection is in many cases almost impossible, and we are convinced that the only way of avoiding the introduction into a mine of a dangerously imperfect lamp is to test every lamp in an explosive mixture of air and some inflammable gas before it is allowed to descend the shaft. Though we have good reason to believe that the practice of surreptitiously opening safety-lamps in the workings is much less prevalent than formerly, it is still necessary that such lamps should be locked. We have examined many appliances for this purpose, and we consider that the plan of fastening the oil vessel to the other part of the lamp by a riveted lead plug, impressed at each end with marks or letters varied from time to time, is the simplest, the most efficient, and the one most likely to lead to the detection of any attempt to tamper with the lock. The power and uniformity of illumination given by a lamp can be notably improved by using, as the illuminant, vegetable or animal oil mixed with about one-half of its volume of a petroleum oil of safe flashing-point. The use of petroleum spirit or benzine as the illuminant in safety-lamps instead of vegetable or animal oil, is attended with some advantages, but it is also liable to introduce new sources of danger. Special care is needed in the filling and trimming of lamps, and in the arrangement of lamp rooms, to avoid the ignition of the highly explosive mixture formed by air with the vapour arising from this spirit. The selling of petroleum spirit, or of spirit of similar character as to volatility, under designations which are calculated to mislead in regard to the nature of the illuminant, is a proceeding fraught with danger, unless all vessels containing such illuminants bear a prominent label indicating the dangerous nature of their contents. Stringent regulations as to the conditions under which illuminants of this class are to be used and stored are absolutely necessary.

The advantages in point of convenience and efficiency which attend the employment of electric glow-lamps for illuminating the pit's bottom and roadways immediately adjacent to it have already been demonstrated at several collieries where this utilisation of the electric light has been combined with illumination at the surface by arc lights. In applying electric glow-lamps to underground illumination, to the extent indicated, through the medium of conducting cables leading from the generators to the pit bottom, it is essential to safety, as well as to the permanent efficiency of the installation, that the cables should be placed in positions where they are thoroughly protected against possible accidental injury. It is also essential, in all mines where fire-damp has been known to occur, that the glow-lamps should be excluded from direct contact with the air of the mine in one or other of the ways indicated in this report. Portable, self-contained electric lamps have been devised which will furnish for several successive hours a light considerably superior to that of the best safety-lamps, and which at the expiration of eight hours and upwards will still give a light fully equal to that of a freshly lighted Davy lamp. These lamps are perfectly safe, but as they do not afford any indication of the condition of the atmosphere in a mine, their employment, even if special fire-damp detectors are used, cannot in any case entirely dispense with the necessity for the use of some safety-lamps. For exploring purposes after accidents, or in foul places, these lamps must prove very valuable even in the present condition of their development, and as auxiliary lights they cannot fail to prove very useful. The great progress which has recently been made in the construction of portable electric lamps affords promise of a speedy utilisation of such lamps to an important extent in coal-mines.

While we think that the safety-hooks at present available may have contributed to prevent fatalities from over-winding, we believe that the best appliance for the purpose is an automatic steam brake attached to the winding-gear, and we think it desirable that such brake should be introduced where practicable.

We consider that measures should be adopted to deal more systematically, and if possible more expeditiously, with casualties resulting from the various sources of accidents dealt with in this report. Collieries or mines should be required to provide an ambulance and stretchers for the purpose of conveying to their homes sufferers from injuries received while in the discharge of their duties. Arrangements should be made for the establishment of centres in mining districts, where additional appliances for succour and relief, and also special appliances for exploring purposes, should be maintained in an efficient condition, so as to be ready for use at the shortest notice. It is most desirable that facilities should be afforded for the instruction of men in the use of special auxiliary appliances for exploring purposes, and in simple measures connected with the provisional treatment of injuries. We attach great importance to the systematic inspection of each mine by the workmen, as provided for in General Rule 30 of the Coal Mines Regulation Act, 1872, and we recommend that this provision should be generally and regularly acted upon.

Concluding Observations

In submitting to your Majesty the results of our inquiries and experimental work, and the conclusions to which they have led us, we desire to express our regret at the unavoidable delay which has occurred in the presentation of our report. This delay has been due to the wide range of important and very extensive subjects included in the reference to us, and to the great difficulties we have experienced in bringing to a close the experimental work upon which we have been engaged, almost continuously, since we first entered upon the inquiry intrusted to us. These difficulties have arisen in part out of the constant succession of inventions and suggestions submitted to us in connection with the questions under investigation, many of which demanded careful consideration and necessitated the institution of fresh experiments. They have also been in part due to the circumstance that, as our investigations progressed, the results obtained opened up new fields into which it was necessary to extend our inquiries. In bringing our labours to a termination, we feel very strongly that many of the subjects with which we have dealt need much further elucidation by perseverance in experimental research of the kind which we have pursued. We are convinced that if the work which we are relinquishing were continued, the knowledge of the conditions to be fulfilled for securing safety from preventable disasters, and the development of resources and appliances calculated to promote the fulfilment of those conditions, could still be much advanced. It is moreover certain that new subjects for inquiry connected with the safe working of coal-mines must continue to present themselves, as has been the case during our seven years' experience. These considerations have impressed upon us the need for the official establishment of some permanent arrangement by which the continuous pursuit of this highly important class of work would be secured, and by which, also, the merits of suggestions and inventions presenting themselves from time to time would be investigated properly and thoroughly, and dealt with authoritatively. We consider, moreover, that the complete investigation of coal-mine disasters would be greatly promoted if the arrangements to which we have referred were utilised systematically, in connection with the usual official inquiries, in dealing with the difficulties which frequently arise in elucidating the causes of these disasters.

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March 15, 1886

SCIENTIFIC SERIALS

IN the *Journal of Botany* for March Mr. G. A. Holt describes and figures a species of moss, *Thamnium angustifolium*, not only new to Britain, but new to science. It was found sparingly in Derbyshire.—Mr. J. G. Baker concludes his comparison of the British and Continental forms of the difficult genus *Rubus*.

Proceedings of the Linnean Society of New South Wales, vol. x. part 3, Sydney, December 21, 1885.—This part contains the proceedings of this most energetic Society for July, August, and September, 1885, and memoirs by the following:—Dr. R. von Lendenfeld, monograph of the Australian sponges, part 5 (plates 26–35). The Auleninæ, order 3, the Ceraospongiæ, Halme, Aphrodite, Aulena, and Halmopses are established as new genera. part 6 (plates 36–38), on the genus Euspongia.—On a sponge destructive to oyster culture in the Clarence River, a new species of Chalinulæ.—Addendum to the Australian sponges.—Addendum to the Australian Hydromedusæ.—Note on the Glacial period in Australia.—W. A. Haswell, M.A., jottings from the Biological Laboratory of the Sydney University, on an Australian species of Bonellia; on a greater respiration in fresh-water turtles. From observations on the Australian *Chelodina longicollis*, thinks the phenomena described by S. H. Gage as auxiliary respiration extremely improbable and that the Chelonian can bear with impunity being deprived of oxygen for lengthened periods; but the facts recorded by Simon and Susanne Gage in the March 1886 number of the *American Naturalist* cannot thus be interpreted.—Capt. Hutton, on the supposed Glacial period in Australia.—N. de Miklouho-Maclay, plants used by the natives of the Macleay Coast, named by Baron Müller.—George Masters, catalogue of the hitherto-described Coleoptera of Australia, part 1, Cicindelidæ and Carabidos (960 species enumerated).—J. Douglas-Ogilby, three new fishes from Port Jackson; notes on the distribution of some Australian sharks and rays.—A. Sidney Olliff, new species of Australian Coleoptera belonging to the genera Lacordairia, Xanthophæa, Plagioteium, Catosiopus, and Rhysodes.—W. Macleay, on a new genus (Phalacrognathus) of the sub family Lamprimides.—Rev. Dr. Wools, on double flowers.—K. H. Bennettt, remarks on the decay of certain species of Eucalyptus. The species were almost without exception *E. mellidora* and *E. rostrata*, and the cause is ascribed to the enormous increase in the numbers of the opossums. Some idea of the number of this animal in a portion of Gipps' Land may be had from the fact that four men in a short time procured a quarter of a million of skins.

Rivista Scientifico-Industriale, February 28.—Description of a new telescope, the "plesiotelescope," by Prof. Nicodemo Jadanza. This is an astronomical instrument intended for the study of near and distant objects. It is constructed with an achromatic objective, M, to the second focus of which is attached a second lens, N, at a less focal distance than that of the lens M. These two lenses form a compound objective, which brings into view objects at short and great distances.—A new application of electrolysis, by G. F. The anonymous author describes a process for producing damascened work rapidly and economically by electrolysis.—Note on the explosion of boilers in steam-engines, by Prof. Giovanni Luvini. The author traces the bursting of boilers to their chief causes, suggests a practical remedy, and offers some remarks on a means of generating steam with a saving of fuel.—A description of Prof. E. Lommel's aërostatic scales for determining the specific weight of gases, by G. Faè.

Bulletin de l'Académie Royale de Belgique, January.—Description of some crystals of calcite, by Prof. C. Casaro. The author describes a first series of Belgian calcites, comprising the crystals found along the left bank of the Meuse and in some other localities. These are reduced to thirty-two simple forms, of which three are new.—On the difference of sea-level in winter and summer, by Gen. Commines de Marsilly. It is argued that the Polar seas must be higher in summer than in winter, when the accumulation of ice increases the salinity, consequently also the density, of the water.—Note on the display of meteors observed throughout Belgium on November 27, 1885, by F. Folie. The maximum of intensity was generally about 6 p.m., when as many as 155 meteors were observed in a single minute at Louvain.—A contribution to the study of the germ-cell in the lower animal organisms, by C. Van Bambeke.—On the coefficient of internal friction of fluids: determination of its variations according to temperature. Theoretical considerations suggested by the observation of these variations, by P. de Heen.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 11.—"On Systems of Circles and Spheres." By R. Lachlan, B.A., Fellow of Trinity College, Cambridge. Communicated by Prof. A. Cayley, F.R.S.

This memoir is an attempt to develop the ideas contained in two papers to be found in the volume of "Clifford's Mathematical Papers" (Macmillan, 1882), viz. "On Power Co-ordinates" (pp. 546–55), and "On the Powers of Spheres" (pp. 332–36). The conception of the "*power* of two circles," or spheres, as an extension of Steiner's use of the "*power* of a point with respect to a circle," is due to Darboux.

The memoir is divided into three parts: Part I. consists of the discussion of systems of circles in one plane; Part II. of systems of circles on the surface of a sphere; and Part III. of systems of spheres.

The power of two circles is defined to be the square of the distance between their centres less the sum of the squares of their radii.

Denoting the power of the circles (1, 2) by $\pi_{1,2}$ it is proved that the powers of any five circles (1, 2, 3, 4, 5) with respect to any other circles (6, 7, 8, 9, 10) are connected by the relation—

$$\begin{vmatrix} \pi_{1,6} & \pi_{1,7} & \pi_{1,8} & \pi_{1,9} & \pi_{1,10} \\ \pi_{2,6} & \pi_{2,7} & \pi_{2,8} & \pi_{2,9} & \pi_{2,10} \\ \pi_{3,6} & \pi_{3,7} & \pi_{3,8} & \pi_{3,9} & \pi_{3,10} \\ \pi_{4,6} & \pi_{4,7} & \pi_{4,8} & \pi_{4,9} & \pi_{4,10} \\ \pi_{5,6} & \pi_{5,7} & \pi_{5,8} & \pi_{5,9} & \pi_{5,10} \end{vmatrix} = 0,$$

which may be conveniently written—

$$\pi\begin{pmatrix} 1, & 2, & 3, & 4, & 5 \\ 6, & 7, & 8, & 9, & 10 \end{pmatrix} = 0.$$

This is the fundamental theorem of the paper; it is shown that, if the power of a straight line and a circle be defined as the perpendicular from the centre of the circle on the straight line, and the power of two straight lines as the cosine of the angle between them, then the theorem is true if any circles of either system be replaced by points, straight lines, or the line at infinity.

The general theorem is then applied to prove some properties of special systems of circles, and more particularly those systems of circles which have analogous relations to three circles, as the circum-circle, the inscribed, and nine-points circle of a triangle have to the straight lines forming the triangle.

The rest of Part I. is taken up with a discussion of equations expressed in terms of power-co-ordinates. The "power-co-ordinates" of a point are defined as any multiples of its powers with respect to a system of four circles which have not got a common orthogonal circle.

The equation of the first degree represents a circle, or straight line; and the equation of the second degree a bicircular quartic, or circular cubic, and these curves are discussed in some detail.

Part II. contains merely the extension of the results of Part I. to spherical geometry; the power of two circles on a sphere is defined to be $\tan r \tan r' \cos \omega$, where r, r' are their radii, ω their angle of intersection: the power of a small circle, radius r, and a great circle is defined as $\tan r \cos \omega$, and the power of two great circles as $\cos \omega$.

The fundamental theorem is as before

$$\pi \begin{pmatrix} 1, & 2, & 3, & 4, & 5 \\ 6, & 7, & 8, & 9, & 10 \end{pmatrix} = 0,$$

connecting the powers of the systems of circles.

Consequently the results obtained previously are extended with but slight modification.

In Part III. the method of Part I. is applied to spheres; it is proved at once that the powers of two systems of spheres must satisfy the relation

$$\pi \begin{pmatrix} 1, & 2, & 3, & 4, & 5, & 6 \\ 7, & 8, & 9, & 10, & 11, & 12 \end{pmatrix} = 0,$$

where any of the spheres may be replaced by planes, or the plane at infinity.

The discussion of the equation of the first degree in power-co-ordinates is much the same as that in Part I. The equation of the second degree represents a cyclide of the fourth or third order, but the reduction of the equation to its simplest form is more complicated than in the case of bicircular quartics. It is shown that there are four distinct canonical forms, each of which includes several species of surfaces. The different species are then discussed in detail.

March 25.—"Remarks on the Cloaca and on the Copulatory Organs of the Amniota." By Dr. Hans Gadow. Communicated by Prof. M Foster, Sec. R.S.

The first portion of this communication contains an account of the sphincter and copulatory muscles, the derivation of which from skeletal and from visceral muscles is followed up in the Sauropsida and Mammalia, partly aided by the study of the nerve-supply.

Then follows an extensive description of the modifications of the cloaca of the chief groups of the Amniota. Hatteria comes nearest the Amphibia. Chelonia represent a type intermediate between that of the Ostriches and Crocodiles, and that of the Monotremes, from which again a continuity of stages up to the highest Placentalia can be traced.

The anal sacs of the Chelonia are discussed with reference to experiments on their being able to take in water. The peritoneal canals of Crocodiles and Tortoises are still functional, but in Hatteria they are rudimentary. Muellerian ducts are present in the males and Wolffian ducts in the females of young Crocodiles. Space will not permit to mention more than the following of the general conclusions drawn regarding the phylogenetic development and the homologies of the various organs treated in this paper.

The whole cloaca of the Amniota consists originally, either permanently or in the embryo only, of three successive chambers, which may be distinguished as follows:—

I. The Proctodæum (termed thus by Prof. Lankester). It is the outermost anal chamber of epiblastic origin. With its derivatives: (1) bursa Fabricii in birds; (2) various hedonic glands in most Amniota; (3) the copulatory organs, the at least partly epiblastic nature of which is indicated by the frequently developed horny armament of the glans, by the various sebaceous glands, and, as shown in this paper, by its development.

II. The Urodæum, from οὖρον and δαίω. Hypoblastic. This is the middle chamber or primitive cloaca, into which open the urinogenital ducts, and through which pass the fæces. With its differentiations: (1) urinary bladder, ventral; (2) anal sacs in Tortoises, dorsal.

III. The Coprodæum, from κόπρος and δαίω. This is the innermost cloacal chamber.

The Urodæum is the oldest portion of the whole cloaca, then follows the Proctodæum, and, lastly, the Coprodæum has secondarily assumed cloacal functions.

The various modifications of these three chambers, their function, and the gradual separation of fæces, urine, and genital products have been discussed in the third chapter.

We can derive the types of the intromittent organs and of the cloaca of the Amniota from conditions which are still represented by the Gymnophiona and by Hatteria, viz. from the walls of the Proctodæum in connection with a certain uro-proctodæal fold. Then Lizards and Snakes followed one line leading to the development of paired organs, whilst the other Amniota modified the same substratum into another, unpaired, ventral form. The Carinatæ show a degeneration in this respect.

The extraordinary resemblance of the organs dealt with in this paper to those of the Chelonia and young Crocodiles can hardly be explained by homoplastic coincidence, but strongly favours the phylogenetic relationship of the Mammalia with the Reptiles. This, however, is but one more link in the long chain, which, being anchored in the Triassic Theriomorpha, makes the Amniota more akin to each other than to the Amphibia.

April 1.—"Description of Fossil Remains of Two Species of a Megalanian Genus (*Meiolania*, Ow.) from Lord Howe's Island." By Sir Richard Owen, K.C.B., F.R.S.

In a scientific survey by the Department of Mines, New South Wales, of Lord Howe's Island, fossil remains were obtained which were transmitted to the British Museum of Natural History, and were confided to the author for determination and description.

These fossils, referable to the extinct family of horned Saurians described in former volumes of the *Philosophical Transactions* (vol cxlix., 1858, p. 43; *ib.* 1880, p. 1037; *ib.* 1881, p. 1037) under the generic name *Megalania*, form the subject of the present paper. They represent species smaller in size than *Megalania prisca*, Ow., and with other differential characters on which an allied genus *Meiolania* is founded. Characters of an almost entire skull with part of the lower jaw-bone, of some vertebræ and parts of the scapula and pelvic arches, are assigned to the species *Meiolania platyceps*. Portions of a cranium and mandible are referred to a *Meiolania minor*. Both species, as in *Megalania*, are edentulous with modifications of the mouth indicative of a horny beak, as in the Chelonian order. The cranial and vertebral characters are, however, sauroid. Horn-cores in three pairs are present, but shorter relatively, especially the first and third pairs, than in *Megalania prisca*. The indication of a seventh more advanced and medial horn is feeble, and the author remarks that in the small existing lizard (*Moloch*) this horn has not an osseous support. The tail of *Meiolania* is long and stiff; the vertebræ being incased by an osseous sheath, developing, as in *Megalania*, tuberous processes in two pairs, corresponding with the vertebræ within: such defensive parts are less developed, relatively, than in *Megalania prisca*.

The locality of these singular remains is an insular tract not exceeding 6 miles by 1 mile in extent, situated midway between Sydney and Norfolk Island, in lat. 31° 31′ S., long. 159° 9′ E. The island is formed of three raised basaltic masses connected by low-lying grounds of blown coral-sand formation, consisting of rounded grains and fragments of corals and shells. In the parts of this formation converted into rock were found the petrified remains which are the subject of the present paper. It is accompanied by drawings of the most instructive fossils: these form the subjects of five plates illustrative of the text.

Mathematical Society, April 8.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—The following communications were made:—On the number of linearly independent invariants (or seminvariants), reciprocants, or in general of integrals of any assigned type of a homogeneous and isobaric linear partial differential equation, by Prof. Sylvester, F.R.S.—On some results connected with the theory of reciprocants, by C. Leudesdorf.—The President (Mr. Walker, F.R.S., in the chair) gave an account of the work he has been for some time engaged upon in connection with elliptic functions, the special points he drew attention to being the use of the twelve elliptic functions, and of twelve zeta and twelve theta functions. The two latter systems of functions depend upon the quantities E, G, I, where $G = E - k'^2K$ and $I = E - K$.—Mr. A. B. Kempe, F.R.S., communicated a note on an extension of ordinary algebra differing from the latter in the substitution of three arbitrary quantities z, i, and u, for the quantities 0, 1, and ∞. Taking z, i, and u to be 0, 6, and 1 respectively, he showed that $2 + 2 = 3$, $2 \times 2 = 3\frac{1}{3}$.—Mr. Tucker read a theorem in conics, by the Rev. T. C. Simmons. Through the focus K of an ellipse chords LKL', MKM' are drawn at angles of 60° with the major axis. A new ellipse is described having K for focus, and LM', ML' for tangents at vertices. Then it will follow that (1) the new ellipse will have the same directrix as the former; (2) its eccentricity will equal half that of former; (3) an infinite number of triangles inscribed in the outer, may be circumscribed about the latter; (4) if the outer ellipse be projected orthogonally into a circle, these projected triangles will all have K for symmedian point, the inner ellipse for Brocard ellipse, and the projections of the intersections of LL', MM', with the inner minor axis for Brocard points; (5) the sine of the Brocard angle will be the ratio of the minor axes of the ellipses, the ratio of the Brocard diameter to the circum-radius will be the eccentricity of the outer ellipse, &c.

Geological Society, March 24.—Prof. J. W. Judd, F.R.S., President, in the chair.—Henry Fisher, Edwin Harman, Henry Johnson, and Edward Alloway Parkhurst were proposed as Fellows of the Society.—The following communications were read:—On the genus *Diphyphyllum*, Lonsdale, by James Thomson, F.G.S.—On additional evidence of the occurrence of glacial conditions in the Palæozoic era, and on the geological age of the beds containing plants of Mesozoic type in India and Australia, by Dr. W. T. Blanford, F.R.S., Sec.G.S. After recapitulating briefly the principal facts known as to the correlation of the Karoo formation of South Africa, the Gondwána system of India, and the coal-measures and associated beds of Eastern Australia, and especially noticing those phenomena in the different strata that had been attributed to the action of ice, the author proceeded to describe the additions recently made to previous knowledge by various members, past or present, of the Geological Survey of India, and especially by Mr. R. Oldham and Dr. Waagen. These additions had recently been published in the Records of the Geological Survey of India. Mr. R. Oldham, in a recent visit to Australia, had come to the same conclusion as all other geologists who had visited the country, and clearly showed, as the Rev. W. B. Clarke and many others had done, that beds containing *Glossopteris*, *Phyllotheca*, and *Næggerathiopsis* were intercalated among marine beds with Carboniferous fossils. The age of these marine beds was shown by Dr. Waagen to be that of the European coal-measures. Mr. Oldham had, however, further ascertained the presence in abundance of smoothed and striated boulders, evidently transported by ice, in the marine Carboniferous beds north of Newcastle, N.S.W., and he consequently considered these beds, and not the overlying Hawkesbury, the equivalents of the Bacchus-marsh beds of Victoria, and of the Talchirs of India, a view which was in accordance with the relations of the fossil flora. Meantime Dr. Waagen had received from Dr. H. Warth some fossils from the Salt-range of the Punjab. The fossils came from the upper part of a boulder-bed, the resemblance of which to the Talchir group at the base of the Gondwána system had long been recognised, but which had hitherto been classed with a stage immediately overlying, containing Upper Cretaceous fossils. The fossils now found by Dr. Warth included two forms of *Conularia* found in the Australian Carboniferous rocks, besides some other species evidently of Carboniferous age. Dr. Waagen consequently classed the boulder-bed together with other similar formations in other parts of the Salt-range as Carboniferous. There was one difficulty, the fossils just referred to were considered by Mr. Wynne to be contained in pebbles derivative from another bed. It was, however, shown that this did not affect the age of other boulder-beds in the Salt-range, and that the latter were connected with the Talchir beds in Central India by another discovery of Mr. R. Oldham's, that a boulder-bed in the Indian deserts was also probably of Talchir age, and that the question as to whether the nodules containing the *Conulariæ*, &c., were concretions or pebbles might await further examination in the field. Another contribution to the question had been made by Mr. Griesbach, who had recently found a boulder-bed which, from its character and fossils, he considered as Talchir, in the neighbourhood of Herat. It was pointed out that the existence, over such extensive areas, of boulder-beds, all of which might, without any improbability, be of approximately the same age, rendered it highly probable that all were really contemporaneous and due to one Glacial period; that this period must have been towards the close of the Palæozoic era, which it may possibly have terminated by exterminating many of the principal forms of life. The peculiar flora of the Australian Newcastle beds and of the Indian Damudas, having nothing in common with the contemporaneous European Carboniferous flora, afforded an important proof of distinct botanical provinces in past times.

Geologists' Association, April 2.—On grasses, by J. Starkie Gardner, F.L.S. The paper was an inquiry as to the geological period at which grasses first commenced to assume a preponderating position in vegetation. Their value and importance at the present day was first sketched, and it was remarked that they occupy under cultivation one-third of the entire area of Europe, inclusive of lakes and mountains, while, exclusive of malt and spirituous drinks distilled from them, their products to the value of nearly one hundred millions sterling are imported annually into this country alone. There are over 3000 species, fitted to occupy most diverse stations and to overcome nearly every kind of competition under no matter what conditions, with the result that about 95 per cent. of the plants growing in ordinary meadow-land are grasses. The conclusion arrived at was that there was no great development of grasses until towards the close of the Eocene, no definite remains being associated with any of the older Eocene floras of temperate latitudes. A number of facts were brought forward to show that grasses could by no possibility have failed to become associated with the remains of other plants in beds deposited under such conditions as those of the Eocene had they existed in any profusion then, while further to support this argument it was stated that the very similar Oligocene and Miocene beds all over Europe are crowded with them. Further it was shown that the dentition of all the early Eocene herbivorous Mammalia was adapted for crunching fruits, snapping twigs, and grubbing up roots, rather than for browsing on such food as grass, so that the evolution of true Graminivora, as well as the specialised Carnivora that prey on them, must be post-dated to the appearance of the grass itself. The geological history of the whole class of insects was reviewed, with the object of supporting the conclusion arrived at as to the *post* mid-Eocene date of grass. Older remains of grass may, however, occur in the vast series of Tertiary deposits in Spitzbergen, but as yet their age has not been accurately correlated. Finally, it was shown that the introduction of an aggressive type in vast numbers and of different habits to pre-existing vegetation, exerted an influence on terrestrial life altogether without parallel, and for the first time rendered possible the development of a meadow and prairie vegetation, as distinct from that of marsh, scrub, and forest, with all the attendant forms of animal and vegetable life to which such vegetation is indispensable.

Physical Society, March 27.—Prof. W. G. Adams, Vice-President, in the chair.—Mr. A. R. Wright was elected a Member of the Society.—The Chairman read a letter from Dr. Alder Wright, Secretary to the "Tribe Fund" Committee, in which reference was made to the scientific work of the late Mr. Alfred Tribe, and an appeal made for funds to aid in the maintenance and education of his family, which, owing to his early death, has been left in straitened circumstances.—The following communications were read:—On an arc lamp convenient for use with the Duboscq lantern, by Prof. S. P. Thompson. The old Duboscq lamp, though working well with a series of Grove's cells, is very unsuitable for use with currents from dynamos. Prof. Thompson has employed as a substitute in the Duboscq lantern a lamp commonly known as the "Belfast arc lamp." The result is all that can be desired as regards steadiness and regularity. The focusing, that is, the adjustment of the arc so that it shall remain unchanged in position, is effected by a wheel below the lantern, which is moved by hand.—On a modified Maxwell's galvanometer, by Prof. S. P. Thompson. The galvanometer consists of a light frame of copper, upon which is a coil of wire. This is suspended between the poles of a horseshoe magnet, and a piece of soft iron is placed within the coil, but free from it, which concentrates the magnetic force between the poles. The coil is suspended by two silver wires, by which it is in connection with two binding screws on the base of the instrument. The galvanometer is extremely simple in adjustment, and very dead beat; it has also the advantage of being affected to an inappreciable extent by neighbouring magnets and currents, with a current in its own coils; when no current is in it, it is of course quite unaffected. The reading is effected by the ordinary lamp, mirror, and scale arrangement.—On the expansion of mercury between 0° and − 39° C., by Profs. W. E. Ayrton and John Perry. On November 14, 1885, Mr. G. M. Whipple gave the Society the results of the examination of thermometers down to the melting-point of mercury. There was, however, no evidence as to whether the contraction of the mercury continued uniform, as the thermometers were only compared with mercurial ones. The authors have therefore examined this point, and have made a series of comparisons of a mercurial thermometer, lent them by Mr. Whipple, with a constant volume air-thermometer, both immersed in a bath of frozen mercury, which was allowed to gradually become warm. The result obtained was that no certain deviation from a linear law could be detected in the expansion of mercury when temperature was measured by the increase of pressure required to keep a volume of air constant. Hence temperatures down to − 39° C. may be correctly measured by a mercury thermometer the stem of which is graduated for equal volumes.—On the expansion produced by amalgamation, by Profs. W. E. Ayrton and John Perry. It has been accidentally observed by the authors that the amalgamation of brass is accompanied by great expansive force. If one edge of a straight thick brass bar be amalgamated, it will be found that in a short time the bar is curved, the amalgamated edge being always convex, and the opposite concave. The authors imagine that a similar action may be the primary cause of the phenomena presented by the Japanese "magic mirrors." Japanese mirrors are made of bronze, and have a pattern cast upon the back, and although to the eye no trace of it can be discovered upon the polished reflecting surface, yet, when light is reflected by certain of these mirrors on to a screen, the pattern is distinctly visible in the luminous patch formed. In a paper before the Royal Society they have shown that this is due to the polished side opposite the thinner parts of the casting being more convex than the others, a conclusion verified by the fact that the pattern is reversed when formed by a convergent beam of light. Such a condition of things would evidently result from a uniform expansive stress taking place over the reflecting surface, the thinner, and consequently the weaker, parts becoming more convex or less concave than the others. The authors have hitherto attributed this inequality of curvature to a mechanical distortion to which the mirrors are intentionally submitted during manufacture, to produce the general convexity of the polished surface, but they now think it possible that the use of a mercury amalgam in the process of polishing may have an effect in the production of this inequality of curvature.

Victoria (Philosophical) Institute, April 5.—A paper by Mr. W. P. James, F.L.S., giving a careful *résumé* of the various records of the Creation current among nations in ancient and modern times, was read.

Institution of Civil Engineers, April 6.—Sir Frederick Bramwell, F.R.S., President, in the chair.—The paper read was on water-purification: its biological and chemical basis, by Percy F. Frankland, Ph.D.

Dublin

Royal Society, February 17.—Physical, Experimental, and Applied Science Sections.—Prof. W. F. Barrett in the chair.—Prof. E. Hull, LL.D., F.R.S., read a paper on the different varieties of Irish paving sets. The use of Irish paving materials is of comparatively recent date, North Wales having been the chief source of supply. Granite, which affords comparatively tough paving sets, capable of preserving a rough surface, is worked at Bessbrook, Goraghwood, and Castlewellan. Whinstone, similar to that of Penmaenmawr in Wales, and from rocks of the same group, is worked at Ballintoy, Co. Antrim, and Arklow, Co. Wicklow. The author expressed the opinion that sets of the granitoid class were most serviceable in those parts of a city where the traffic was of an ordinary character, but where it was excessive in quantity and weight pavingstones of the whinstone class, especially if largely crystalline, were preferable.—On a sine and tangent galvanometer, by Prof. G. F. Fitzgerald, F.R.S.—An improved method for determining the specific gravity of solids, by R. J. Moss, F.C.S. This is an application of Sprengel's specific-gravity tube to solids. The tube employed consists of two parts fitting together by an accurately-ground joint the full width of the tube. The error arising from this joint may easily be reduced to one-tenth of a milligramme. With a tube of 1 cubic centimetre capacity, about 2 grammes of most minerals can be employed. If benzene or turpentine be used instead of water, no difficulty arises with air-bubbles. Results sufficiently accurate for determinative purposes can be obtained with even 20 milligrammes of the solid body.

Natural Science Section.—Prof. J. P. O'Reilly, C.E., in the chair.—On some recent discoveries in the salt-range, Punjab, by Mr. A. B. Wynne. Certain peculiarities of the section at different parts of the range were described, and attention was called to the absence of any recognisable Devonian formation in the neighbouring parts of the country, as well as in the salt-range itself, which added interest to the recent discovery by Dr. H. Warth of fossils believed to be of Devonian age, occurring as rolled and derived or transported inclusions of some of the later Jurassic or Cretaceous conglomerates. Specimens of these fossils were exhibited; the most characteristic is Conularia. It was suggested as probable that the parent beds lay to the southward. Other cases of derivative fragments amongst the Salt-Range series having an equally obscure origin were mentioned, all pointing to a lost land, perhaps buried under the deserts and alluvial tracts stretching away into Sind.—On the relationship of the structure of rocks to the conditions of their formation, by H. J. Johnston-Lavis, M.D. Communicated by Rev. Dr. S. Haughton, F.R.S.

Edinburgh

Mathematical Society, April 9.—Dr. R. M. Ferguson, President, in the chair.—Mr. J. S. Mackay communicated a note on the divisibility of certain numbers.—Mr. R. E. Allardice discussed the projective geometry of the sphere.—Mr. John Alison gave statical proofs of several geometrical theorems.

Paris

Academy of Sciences, April 5.—M. Jurien de la Gravière, President, in the chair.—Obituary notice of M. A. Lallemand, Member of the Section for Physics, by M. Mascart.—On the constitution of the earth's crust (concluded), by M. Faye. The author concludes that the revolutions of the globe are due, not to contraction caused by a general and uniform chilling process, as hitherto supposed, but to the circumstance, peculiar to the earth, that this chilling process goes on at an accelerated rate and more deeply under the marine basins than under the continents.—On the magnetic perturbation observed throughout France on March 30, by M. Mascart. The disturbance, which began about 8.30 a.m., lasted for over two days, gradually dying out on April 1.—Summary remarks on the fauna of Tonquin, by M. Emile Blanchard. These remarks are made in connection with a collection of insects made in the delta of the Red River by M. Langue, and recently forwarded to the Paris Natural History Museum. It comprises 567 species of Coleopteræ, 90 of Lepidopteræ, and a few of Hemipteræ, Neuropteræ, and other orders. Most of them are common to the rest of Indo-China, but several are new, either indigenous or related to genera represented by more or less divergent species occurring in other parts of the peninsula. This collection shows that on the whole a considerable degree of uniformity characterises the local fauna throughout all the coast-lands of Indo-China.—Note on the specimen of rock brought by M. Lesseps from the hill at Gamboa, on the line of the Panama Canal, by M. Fouqué. This specimen, picked up after the explosion by which the hill was removed, is described as a microlithic volcanic rock, an augitic labradorite with optical properties analogous to those usually occurring in volcanic labradorites.—Remarks on the rocks collected during the soundings of the *Talisman*, by MM. Fouqué and Michel Lévy. Amongst these specimens, mostly obtained from depths of from 4000 to 5000 metres, the older metamorphic is much more generally represented than the eruptive series. Sedimentary rocks also occur in considerable abundance including 73 specimens of limestones, 16 of arkoses, and 19 of sandstones, the latter sometimes rich in remains of biotite and muscovite.—A first experiment with an instrument intended to study the roll of vessels at sea, by Admiral Pâris.—Observations in connection with M. Resal's recent note on the flexion of prisms, by M. J. Boussinesq. The supposed error in M. de Saint-Venant's theory of the flexion of prisms with elliptical base is shown to be due to a mistake made by M. Resal himself in his calculations.—Description of an automatic instrument designed to register the heat liberated by living organisms (one illustration), by M. A. d'Arsonval. By means of this extremely sensitive "thermo-electric calorimeter" the physiologist is enabled to determine and measure the quantity of heat liberated by cold-blooded animals, such as frogs and fishes, and even by inferior organisms, such as insects and larvæ.—Observations on the new planet 254, discovered by M. Palisa at Vienna on March 31, made at the Paris Observatory, by M. G. Bigourdan.—Note on the number of poles at the surface of a magnetic body, by M. Stieltjes.—Construction of the left curve of the sixth order and first genus: transformation of the surface of the third order on a plane, by M. A. Petot.—Note on the late M. Dupuy de Lôme's theory of submarine vessels, by M. Zédé.—Remarks in connection with the preceding note, and on M. Dupuy de Lôme's projected submarine boat, by Admiral Pâris. It is pointed out that the problem of submarine navigation was practically solved in the year 1858 by Admiral Bourgeois, who who actually sailed under water in his *Plongeur*, a model of which is still preserved in the Naval Museum, Paris.—Note on a calculator of steam and fluids at high pressure, by M. Henri Parenty.—On the mathematical problem of anamorphosis, by M. Léon Lecornu.—On a new general method of graphic calculation by means of hexagonal abacuses, by M. Ch. Lallemand.—On the variation produced by a rise of temperature in the electromotor force of thermo-electric couples, by M. H. Le Chatelier.—Note on a new method of photographic reproduction without objective and by the simple reflection of light, by M. Boudet de Paris. The author's numerous experiments prove beyond doubt that a design, a photograph or object of any kind, may be reproduced photographically without the aid of the usual appliances, and with the light of a Carcel lamp.—Note on the tungstates and chlorotungstates of cerium, by M. P. Didier.—On the elimination of the oxide of carbon in cases of partial poisoning, by M. N. Gréhant.—Researches on the therapeutic action of urethane, by MM. A. Mairet and Combemale.—On the reproductive functions of *Doris testudinaria* and some other Gasteropods, by M. E. Bolot.—On some special variations of structure in the organs of the Simple Ascidians, by M. Louis Roule.—On a new process for preserving and economising the hops used in brewing, by M. Louis Boulé. For this process it is claimed that it effects a saving of one-half in the consumption of hops, which are at the same time made to preserve their efficacy for an indefinite period. If generally adopted it will reduce hops to a reasonable price, and remove the inducement to employ deleterious drugs as substitutes.

BERLIN

Physiological Society, January 29.—Prof. Ewald spoke on the significance of the so-called second swallowing noise. As was known, Kronecker and Meltzer, in their investigations into the mechanism of swallowing, had endeavoured to explain the second noise, audible by auscultation in the region of the stomach six seconds after the movement proper of swallowing, by setting forth that through the act of swallowing, the bit eaten was squirted into the upper part of the œsophagus, and then encountered the peristaltic wave of the œsophagus, where, after six seconds, it attained the lower part, and was pressed into the cardiac orifice. It was the contraction of the lower part of the œsophagus which produced the second noise in question. As the result of observations on sound and diseased persons, as also on animals, Prof. Ewald had arrived at another opinion. According to his view the second swallowing noise was generated by the entrance of air into the cardiac orifice. Both in the case of swallowing anything and also in the case of not swallowing anything, whether it were altogether empty swallowing or only saliva trickling down, air penetrated into the lower part of the œsophagus. Air might, however, likewise penetrate from the stomach upwards. In proof of the correctness of this interpretation of the second noise, there was first the fact that this phenomenon was absent when water was so carefully drunk that no air accompanied it on its passage to the cardiac orifice, and second that the noise was sometimes heard without any bit being swallowed. If, now, the second noise of swallowing had not the significance attached to it by Herren Kronecker and Meltzer, neither could it be regarded as any argument in favour of their view that, as had been maintained by these authors, the piece swallowed stayed for six seconds before the cardiac orifice till it got pressed into it. Far from such being the case, the piece swallowed passed continuously into the cardiac orifice, and finally the co-entering air got pressed, with emission of noise, through the sphincter into the stomach.—Dr. Pohl-Pincus gave a sketch of his experiments designed to determine the influence of excitement of spirits and passionate feelings on the hair of the head. Except in the case of one phenomenon, these experiments proved without result. Through long years' experience he had by facts established that in consequence of excitement the hair of the head showed a changed double refraction in the lowest part lying above the papilla, which he called the root-nodule (*Wurzelknötchen*). While under normal conditions this part of the hair appeared white when polarised, when under moderate excitement it fell out it showed the colouring of blue 1 to yellow 2. Under the highest degrees of excitement, again, the highest shades of colour appeared: blue 2 to yellow 3. What was the connection between this material change of the hair and the excitement could not be ascertained. No doubt the nourishment of the hair and the process of cornification of the hair-cells played a part in the matter.—Dr. H. Virchow produced a series of photographs in which the structure of the corpus ciliare in the eyes of various animals came out to view in its multiplicity.—Dr. Benda showed preparations of the central nervous system which were treated with copper hæmatoxyline, and shortly discussed the advantages of this method of colouring for brain and spinal-marrow preparations.

BOOKS AND PAMPHLETS RECEIVED

"Micro-Organisms and Disease," 3rd edition, revised by Dr. E. Klein (Macmillan).—"Nature and the Bible," 2 vols., by Dr. Fr. H. Reusch, translated by Kathleen Lyttelton (T. and T. Clark).—"Fancy Pigeons," parts 7 and 8, by J. C. Lyell (U. Gill).—"Poultry for Prizes and Profit," part 6, by James Long (U. Gill).—"British Cage-Birds," parts 7 and 8, by R. L. Wallace (U. Gill).—"Bees and Bee-keeping," part 8, by F. R. Cheshire (U. Gill).—"Book of the Goat," part 7, by H. S. H. Pegler (U. Gill)—"An Intermediate Physical and Descriptive Geography," new edition (Stanford).—"British Petrography," part 3, April, by J. J. H Teall (Watson, Birmingham).—"The Rotifera or Wheel Animalcules," part 3, by C. T. Hudson and P. H. Gosse (Longmans).—"Journal of Anatomy and Physiology," vol. xx. part 3, April (Williams and Norgate).—"China: Imperial Maritime Customs, Medical Reports for the half year ended March 31, 1885" (Shanghai).—"Notes from the Leyden Museum," vol. viii., No. 2, April (Brill, Leyden).

CONTENTS

THURSDAY, APRIL 22, 1886

INJURIOUS INSECTS

Reports on Insects Injurious to Hop Plants, Corn Crops, and Fruit Crops in Great Britain. Prepared for the Agricultural Department, Privy Council Office, by Charles Whitehead, F.L.S., F.G.S. No. II., "Insects Injurious to Corn, Grass, Pea, Bean, and Clover Crops." (1885.)

Reports of Observations of Injurious Insects and Common Farm Pests during the Year 1885, *with Methods of Prevention and Remedy.* By Eleanor A. Ormerod, F.R.Met.Soc., &c. (London: Simpkin, Marshall, and Co., 1886.)

THE first of these works, a Government Report issuing from the press of Messrs. Eyre and Spottiswoode, and bearing the announcement that it was "Presented to both Houses of Parliament by command of Her Majesty," forms the second of the series, and is a very valuable contribution to the knowledge of the insects destructive to crops mentioned above. It will be of great service to agriculturists, whether scientific or otherwise, as the whole Report from beginning to end is written in a clear and concise manner, without losing any of its accuracy. The Report occupies seventy pages, and of these, forty-nine pages are devoted to "Insects injurious to corn and grass crops." From p. 50 to 56 "Insects injurious to corn in store" are treated of, and from p. 57 to the end "Insects injurious to pea, bean, and clover crops" are dealt with. Each insect has a separate article devoted to it, uniformly treating first of the habits of the creature, the manner and extent of its devastations, then under separate heads the life-history is given, prevention, and remedies.

The crane-fly, or more popularly the daddy-long-legs (*Tipula oleracea*, L.), comes in for a considerable share of attention. Mr. Whitehead reminds us that "It is the larvæ or grubs that injure plants of corn and grass, by attacking them with their strong jaws and eating into them just beneath the surface of the ground, so as either to kill them or make them weak and sickly. In the early spring, if wheat plants which show signs of failing are examined, large ash-grey grubs or maggots will often be found close to the affected plants. Oats and barley are equally liable to harm from these grubs, not perhaps quite to such an extent as autumn-sown wheat, and especially wheat sown after clover leys."

Mr. Whitehead gives the following estimate of loss occasioned by these insects:—"A field of oats sown on March 1, after clover, was attacked by these grubs. Although it was an even strong plant, it was soon nearly half devoured, and, instead of nine quarters per acre being obtained, as might have been expected from the state of the land, and the circumstances of its cultivation, and the produce of other land hard by, only about four quarters per acre were grown. It is computed that the loss in this case amounted to 80*l.*" As an illustration of Mr. Whitehead's manner of treating the life-history of the several insects, the following quotation from that of the daddy-long-legs will suffice:—"The life-history of the crane-flies, both of the *Tipula oleracea* and its close congener *Tipula maculosa*, is simple. The eggs are small, oval, conical grains, shining and black as ebony (as Curtis writes), forming a mass which occupies nearly the whole of the abdomen. As many as 300 have been found in one female. These are deposited, in the autumn, upon grass and herbage, and more frequently in the ground. Wet, undrained meadows and marshy and damp places are preferred by these insects, and the conditions of such spots are probably favourable to the preservation and the ultimate hatching of the eggs. This hatching takes place in the early spring, directly the weather becomes mild. . . . After hatching, the maggots or larvæ grow fast until they become an inch in length. Labourers call them 'leather jackets' because of their tough skins. Their colour is of the earth, with a slight dash of grey or ash colour in it. Although they have no legs, they are able to move rapidly from place to place, and burrow in the ground. It is in this grub form that they do mischief to crops, and they remain in this stage of their existence until the beginning of July, at which period they change into pupæ under the surface of the soil. After a while the pupæ work their way up to the light by means of hooks or recurved spines, and in a short time the crane-flies appear, and soon unfold their long wings and fly away to commence a new series."

After some further notes descriptive of the insects, some instructions are given under the heads of Prevention and Remedies.

It will be seen that the mode of imparting information is of the simplest and clearest description, and in this as well as in the manner of treatment the author has followed Miss Ormerod in her well-known manual, and moreover he frequently quotes her views and opinions expressed throughout her valued reports.

Just as we are finishing this notice Miss Ormerod's ninth annual "Report of Observations of Injurious Insects and Common Farm Pests during the Year 1885, with Methods of Prevention and Remedy," comes to hand. Like its predecessors, it is full of interesting and valuable records. Miss Ormerod has still something more to say on that general pest referred to above—the daddy-long-legs. It is, perhaps, not generally known how difficult the grubs are to kill, but Miss Ormerod's experiments, as recorded in a previous Report, proved that they could endure almost any amount of freezing and yet come to life as the season returned. Speaking of the grubs, one correspondent, in the Report before us, says:—"In my experience, any chemicals applied for their destruction when they begin to make their ravages must destroy the grain. I have had them covered with salt and soot over night, and they have been alive in the morning." Miss Ormerod here notes that "This observation quite agrees with the result of the experiments of Mr. Ralph Lowe (noted p. 26 of Report for 1884), in which grubs covered respectively with quicklime, soot, household salt, and superphosphate, and also some placed in earth mixed with one-fourth of white arsenic, were not at all the worse, excepting those that had been in the arsenic, and even these recovered before the following day. But nitrate of soda had much more serviceable effects."

It is satisfactory to find that the cases of injurious insects which were exhibited for so long a time in the Bethnal Green Museum are being thoroughly overhauled.

Miss Ormerod remarks in the preface to her Report that the rearrangement of these cases, in which are shown insects injurious to crops, fruit, and timber, is now in progress, and promises to be of practical service. "The insects exhibited are for the most part those which are serious in their ravages, and, as far as is possible, they are shown in their various stages (either by specimens, drawings, or models), with samples of injury caused by them accompanying."

Appended to the Report are some special observations on the warble-fly or ox-bot-fly.

ACROSS THE JORDAN

Across the Jordan: Being an Exploration and Survey of Part of Hauran and Jaulan. By Gottlieb Schumacher, C.E. With Additions by Laurence Oliphant and Guy Le Strange. (London: R. Bentley and Son, 1886.)

THIS volume is the last of several recently published by the Committee of the Palestine Exploration Fund, following quickly on the steps of Conder's "Heth and Moab" and Hull's "Mount Seir," and describes with great accuracy a district lying to the east of the Sea of Galilee not often visited; or, if visited, only hastily skirted, by travellers on the road from Jerusalem to Damascus. How little is known of its geographical details may be gathered from a comparison of the excellent map which faces the title-page of the book with any of the best maps now published. The district described embraces the eastern part of the Jaulan and the western of the Hauran, and is remarkable for the number and variety of its works of ancient art, dating from the time of the dolmen-builders to those of the Crusaders, and including structures referable to Jewish, Greek, Roman, and Christian times. How this region came to be explored is narrated by Mr. Walter Besant in the preface. It appears that about a year ago a firman was granted by the Porte for the survey of the district lying between Haifa on the Mediterranean and Damascus, with a view to the construction of a railway. For the western part of this route, namely, that between Haifa and the Jordan Valley, the maps of the Palestine Exploration Society afforded the necessary details; but from the Jordan to Damascus the line of country had to be specially surveyed, and this work was intrusted by the *concessionnaires* to Herr Gottlieb Schumacher. In the course of his work Herr Schumacher was able to make many scientific observations, as well as maps and drawings of villages, structures, and works of art, which he afterwards embodied in the memoir forming the greater part of the present volume. A ready means of publication was found in the active Society which has done so much in elucidating, and embodying in maps and memoirs, the topographical details of Palestine and its borders.

To the geologist, as well as to the antiquarian, the region of the Jaulan and Hauran is full of interest, and the author has added some details on its geological structure which are very acceptable. The best and most recent observations on this subject are those of Prof. L. Lartet, and contained in his work on the geology of the Dead Sea.[1] The country, as is well known, is volcanic, and is largely covered by sheets of basalt, scoriæ, and ashes which have been erupted from numerous vents, some of which lie in the district here described. Several of these, such as Tell-ej-Jabiyeh and Tell-ej-Jemû'ah, reach an elevation of considerably over 2000 feet above the Mediterranean, and therefore of nearly 3000 feet above the surface of the Sea of Galilee. The southern margin of the Jaulan region, as well as of the basaltic formation, is marked by the deep gorge of the Yarmûk (Hieromax of Pliny), to the south of which the soft *Cretaceo-Nummulitic* limestones reach the surface and afford a genial soil to forests of oak. The Yarmûk receives several tributaries from the north, now correctly mapped for the first time, which lay open on their banks fine sections both of the volcanic rocks and of the underlying chalky limestones; and these streams, which are large and swift, are often precipitated over cliffs of basalt, forming fine cascades. One of these in the Wady Seisûn, a tributary of the Rukkad, has a fall of 100 feet, and then, pursuing its course by a succession of cataracts, unites with the larger stream after falling 517 feet in 420 yards. The Rukkad rises at the foot of Mount Hermon Jebel-esh-Sheikh), a little above the village of 'Ain-el-Berbab, and, upon the melting of the snows in early summer, sends a large flood of water into the Yarmûk. It is remarkable, however, that none of these streams depend altogether on surface drainage for their permanent supplies, as they have their sources in springs; and the combined volume of these waters goes to form a river of equal volume with that of the Jordan itself where it leaves the Lake of Galilee. There are clear indications of the existence of large underground reservoirs of water in the basaltic and calcareous formations. The winter snows and "the former and latter rains" of autumn and spring rapidly sink into the fissured and broken strata, and are pent up, either in the mass of the rock itself, or in caverns which have been formed in the limestone by the solvent action of percolating water. These waters probably accumulate under the tracts sloping towards the south from the base of Hermon to the north of the Yarmûk Valley, and when a vent is formed rise to the surface with force. One of these springs, that of Râs-el-'Ain at the village of El Mezeirîh, fills a considerable basin, and is two to three yards across and about two feet deep at its source; others are of nearly equal copiousness and more or less thermal.

The physical phenomena connected with the district described by Herr Schumacher have their counterpart in the volcanic district of Central France, with this exception, that there do not appear to be any examples of the highly silicated class of lavas, such as domite, trachyte, &c., which we generally find associated with the basic varieties. As regards the geological age of the volcanic outbursts, the question is brought within narrow limits by their relations to the Cretaceo-Eocene limestones. Both these formations appear to have been not only deposited, but subsequently upraised and largely denuded, before the volcanic lavas issued forth from their subterranean reservoirs. As this movement and denudation of the strata took place in the Miocene epoch, the volcanic eruptions may be referred, with little uncertainty, in the main to the succeeding Pliocene; an epoch remarkable for outbreaks of vulcanicity over large portions of the globe. At

[1] "Voyage d'Exploration à la Mer Morte," par M. le Duc de Luynes; tome 3me, "Géologie" (Paris).

the same time it is not improbable that the first outbursts may be dated back to the later Eocene, and the last to the period when the waters of the great Jordan-Valley Lake had receded from their original limits to those within which they are now restricted.

The physical details form but a small part of the volume, which contains a large number of carefully drawn figures of works of art and architecture, accompanied by descriptive text, showing that the region, now the abode of Fellahin—or of migratory Arabs—was one of importance during long centuries of successive dynasties and races. The book cannot fail to be of value to students of Biblical and ancient history, and we are promised by Herr Schumacher descriptive drawings and maps of another section of the Hauran country.

HARBOURS

The Design and Construction of Harbours. A Treatise on Maritime Engineering. By Thomas Stevenson, P.R.S.E., &c. Third Edition. Pp. xiv. + 355. Twenty-four Plates. (Edinburgh: A. and C. Black, 1886.)

THIS work is a reprint, with large and valuable additions, of the article "Harbours" in the Encyclopædia Britannica." Its importance may be gauged from its acceptance in successive editions of that "Encyclopædia, and from its having passed into three editions in the separate and enlarged form.

An important feature is the attempt to lay down general principles, and to discuss and reduce as far as possible to calculation the effect of the great forces of wind and water, and to regulate both the general design and the details of constructions thereon. To the earlier engineers this was mere guesswork, *e.g.* Smeaton is said (p. 41) to have described these forces as "subject to no calculation." Many striking instances of the maximum effect of wind and waves are given, *e.g.* at the top of Whalsey Skerries (Zetland), at a height of 74 feet above high water, large blocks up to 13½ tons were found to have been lifted and transported by the waves (p. 45). Again, two blocks of 1350 tons and 2600 tons were shifted bodily at the Wick breakwater in two storms in 1872 and 1877. At Dunbar, pressures of 3½ tons per square foot for the direct wave-action (p. 56), and of 1 ton per square foot for the backwash (p. 131), were recorded upon a dynamometer of the author's invention; and, by use of two instruments at different levels, it was found that the pressure at the upper level may (exceptionally ?) be twice that at the lower level (p. 56). It is much to be wished that extensive and systematic observations of this kind were made, as instances are quoted wherein only 80, 144, and 70 lbs. per square foot had been assumed in the design of lighthouses and harbours (p. 58). Scott Russell's opinion is quoted (p. 106), and accepted, that the most violent action on sea-works is from those waves which form ground-swell or rollers, and are "waves of translation," *i.e.* vast masses of solid water moving horizontally with great velocity; and that the only way of opposing them is by masses too heavy for them to move.

A useful feature of the work is the presentation of 28 cross-sections of quay-, dock-, and harbour-walls, and breakwaters, beginning with the jetty of old Dunkirk (1699); also of 10 cross-sections of lighthouses, beginning with Winstanley's Eddystone (1699).

A chapter (47 pp.) is devoted to materials. A good deal is said about their decay under water. No ordinary material seems free from this. All timber is eventually destroyed by borers (oddly termed *insects* in this work!) of different sorts; even greenheart and creosoted timber, till recently thought borer-proof, have now given way to their special borers. Most stone, and even rock *in situ*, has its own special borer. Iron gives way by rusting, perhaps at a rate of three-quarters of an inch in a century. Bronze alone seems to stand sea-water, but is too expensive to be extensively used.

Ten pages are given to the use of Portland cement concrete, and some remarkable instances of its use are detailed, *e.g.* the concrete cylinder foundations (12 feet diameter, 30 feet length) of the Plantation Quay at Glasgow, and the use of 350-ton blocks (say 5000 cubic feet) laid in 24 feet of water at Dublin (1885).

Attention is drawn to a new and seemingly very promising American cement styled "carbonite," which is said to stand an ultimate pressure of 8000 lbs. per square inch, or *eight times* as much as Portland cement. Trial of this cement in England is much to be wished. Its preparation is apparently a secret, as though four pages are devoted to its use and properties, its main ingredients are only hinted at as being various hydrocarbons.

Two chapters (39 pp.) are given to the difficult subjects of training works for preserving the outfall of harbours and rivers, and preventing silting in estuaries. An interesting instance of the great commercial advantage of even a small increase of depth in a harbour is that of Leith, where an addition of only 2 feet of depth at the Albert Dock gave 296 tides yearly of 23 feet depth against 102 tides of that depth at the Victoria Basin.

Attention is drawn to the disadvantage of harbours being constructed as local instead of as national works. Want of funds has thus repeatedly led to harbours being designed too small for future wants, and being afterwards enlarged at greatly increased cost, the whole works having to be destroyed to make way for the new.

One of the least satisfactory parts of this work is the formulæ, the range of applicability of several of the empirical ones being very doubtful. One (which should have been definite) on strength of lock-gates (p. 191) is misprinted

$$S = \tfrac{1}{2} W \sec\phi + \tfrac{1}{20} \operatorname{cosin}\phi.$$

By reference to the original (*Trans.* Inst.C.E., vol. i. p. 67) it is seen to be

$$S = \tfrac{1}{2} W \sec\phi + \tfrac{1}{20} W \operatorname{cosec}\phi.$$

Moreover, the meaning of W is misquoted as "pressure on the length of the gate, &c.," instead of "pressure on the length l, &c." (l being only the half-breadth of lock), and the meaning of the result S is given, in words which are barely intelligible, as "whole transverse strain at angle ϕ": the context of the original shows that this should be "whole transverse strain applied at middle of gate" (strain being understood to mean pressure). These defects occur in the "Encyclopædia Britannica" (9th ed.) as well as in the separate work (3rd ed.).

On p. 243 a table of values of a "constant" of strength of various timbers is given without explanation of the meaning of the "constant."

Space might have been saved by the exclusion of special subjects, *e.g.* lighthouse apparatus, &c., which could not be treated at adequate length.

A short glossary of uncommon terms would have been decidedly useful, *e.g.* alveus, bollard, kant, pawl, scend, staith.

These blemishes are, however, small compared with the great merit of the work as a whole, which deals with the difficult and important subject of harbours in a thoroughly masterly manner.

ALLAN CUNNINGHAM, (Major, R.E.)

OUR BOOK SHELF

A First Course of Physical Laboratory Practice. By A. M. Worthington, M.A., late Assistant Master at Clifton College. (London: Rivingtons, 1886.)

PROBABLY no one has so successfully carried on practical science teaching in schools as the author whose excellent work at Clifton College has done so much to gain for that institution an enviable reputation. He therefore is specially fitted to write a "First Course of Physical Laboratory Practice" which shall contain just that which the schoolmaster who is endeavouring to supplement mere lectures with the necessary practical work requires.

In the introduction the author explains the system of science teaching at Clifton. He insists on the importance of from the first making boys themselves measure and experimentally confirm geometrical, mechanical, and physical laws, not necessarily with expensive and elaborate apparatus, such as may be best suited for making determinations of the greatest accuracy, but by the most simple and obvious methods, which are likely to lead to results quite accurate enough to show the truth of the law being examined. The pupil is thus from the first taught to learn the value of simple and often extemporised apparatus, instead of acquiring the very general distrust in anything that has not been highly finished by the professional instrument maker.

Here much that is of great value to those intending to introduce practical science teaching into schools will be found, such as descriptions of fittings, original and working cost, and the time that the several courses of instruction should occupy.

The book is divided into nine parts as follows:—1, Mensuration, 23 experiments; 2, Hydrostatics, 15 experiments; 3, Barometer and Boyle's Law, 3 experiments; 4, Mechanics, 39 experiments; 5, Elasticity, 20 experiments; 6, Heat, 42 experiments; 7, Magnetism, 55 experiments; 8, Statical Electricity, 57 experiments; 9, Current Electricity, 16 experiments. The two branches of physics, light and sound, are not included.

The first part is especially valuable as an introduction to laboratory practice of any kind. It is full of examples in which a good way of observation is contrasted with one or more bad ways, so that the pupil soon learns, or ought to learn, method in observation, to choose that way in which error of observation shall least affect the result.

If it is possible to point out any parts as being more excellent than the rest, the chapters on mechanics and elasticity may be mentioned. It is shown how, by means of one or two boxwood scales, a few weights, some pieces of catapult india-rubber (but for sufficient reasons it is not called catapult india-rubber), and some other equally simple and easily obtained articles, a course of experiments of the utmost value can be performed. A pupil must, if he gives his mind to the subject, learn more of the principles of mechanics, of the reasons of things—not the mere "pulley, wedge, and lever" mechanics of the ordinary text-books—than as yet the majority of people have ever acquired.

There is only one sentence which might with advantage be modified as being not strictly correct, though any false impression which it would produce might be removed by the more exact statements five pages later. Having shown that the bending of a lath depends on its length, the author proceeds to show that thickness affects the bending. He says:—"Now take a lath of double the thickness, or, what is the same thing, lay on the first lath a second similar one, and put on the same weight, . . ." This would be a serious blunder to make if the effect of depth were not well shown later. As the fact that the stiffness of a beam is directly proportional to its width is explained by considering it as equivalent to beams side by side, the opportunity is lost, when the effect of depth is considered, of showing that a beam is *not* equivalent to beams lying above one another, and why.

As a text-book for school use, Worthington's "First Course of Physical Laboratory Practice" is highly to be recommended.

Lectures on Heat, Sound, and Light. By Richard Wormell, D.Sc., M.A., Head Master of the City of London Middle-Class Schools. (London: Thomas Murby.)

THE distinguishing feature of this book is its gradually progressive character. The subjects are supposed to be taken in the order in which they are given. "*Heat* being far simpler in itself, and so much easier to explain, is placed first, while *Light*, being essentially more intricate than either *Sound* or *Heat*, is placed last." The lectures on *Heat* are adapted to the minds of pupils when first receiving instruction in a scientific subject; as the mind develops the lectures advance in character, so as to make full use of the increased intelligence of the pupil, and ultimately, when light is reached, the perfection of the undulatory theory can be presented with some hope of its being appreciated.

After each of the three parts questions are given, and, what is far more valuable, a few pages of instruction in laboratory practice.

The book is illustrated by many figures, which are often explanatory diagrams rather than pictures. Such diagrams have far more educational value than cuts from photographs of apparatus, but the want of proportion may be carried so far as to give a misleading idea of what a thing is really like—thus, the gridiron pendulum is shown nearly as wide as it is long.

There is a curious slip in Fig. 30, which shows how waves travelling along paths differing by half a wave-length come together again in opposite phases, and so neutralise one another; while, if there is a difference of one or more complete wave-lengths, the phase is the same, and they reinforce one another. The slip—it can hardly be called more than a slip—consists in showing the *same* number of wave-fronts in the longer as in the shorter path.

That the book should contain much that is excellent is only to be expected of an author of such experience, while the necessity for turning to such trivial details for criticism is sufficient to show that fault of a serious kind cannot be found.

Une Expérience sur l'Ascension de la Sève chez les Plantes. Par Léo Errera, Professeur à l'Université de Bruxelles. *Comptes rendus* de la Société Royale de Botanique de Belgique, tom. xxv. 2ième partie, 1886.

THIS paper contains an interesting contribution to the question of the course taken by the sap of vascular plants on its way from the roots to the leaves. The view taken by Sachs, that the current passes through the substance of the lignified cell-walls, has, as is well known, been disputed by Böhm, Elfving, and many others, who maintain that it ascends through the cavities of the vessels and tracheides. Various observers have endeavoured to bring the question to an experimental decision by stopping up, in one way or another, the cavities of the water-conducting elements, and then observing whether the current is interrupted. Sachs and Dufour endeavoured to attain this result by sharply bending the stems of actively-transpiring plants, but this method is obviously unsatisfactory, owing to the difficulty of proving that the cavities are completely closed. Elfving attacked the problem in a different way. He injected portions of the stem of woody plants with cocoa-butter, melted at a temperature of 30° C., and satisfied himself that the cavities were really filled up when the injected material had solidified. Under these conditions he found that a pressure of 60 cm. of mercury failed to force any water through the wood, though before the injection 1 cm. of water had sufficed to cause filtration.

To Elfving's experiment two objections have been made. On the one hand, Dufour urged that the absence of the action of transpiration, rather than the closure of the cavities, might well explain the result of the experiment. On the other hand, it was objected by Scheit that the action of the fatty cocoa-butter on the membranes would probably render them impermeable to water, and thus account for a negative result. Prof. Errera has succeeded in modifying Elfving's method in such a way as to meet both these objections.

In the first place, actively transpiring branches were employed for the investigation, *Vitis vulpina* being selected for experiment on account of the large diameter of its vessels. Secondly, instead of cocoa-butter, a solution of gelatine melting at 33° C. was used as the injecting material. This was coloured with Indian ink, so that its presence in the vessels might be easily demonstrated. The action of transpiration was in most cases assisted by the pressure of a column of water 50 cm. in height. The experiments were carried out with all possible precautions, and the result in every case was that the injected branches took up no water, and faded in a few hours, while, under precisely similar conditions, uninjected branches remained perfectly fresh for three days at least, and during that time transpired many cubic centimetres of water. For details and numerical results we must refer to the original.

Prof. Errera's experiments certainly add greatly to the already strong probability that the cavities of the tracheal elements of the wood constitute the channels through which the sap ascends. D. H. 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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Lost Found—Boole Justified and Monge Reinstated in His Rights by Prof. Beman of the University of Michigan, U.S.

In the report of my public lecture on Reciprocants, published in NATURE of January 7 (p. 222), mention is made of a formula, given by Boole in his book on "Differential Equations," which he ascribes to Monge.

Endeavours were instituted in London, Cambridge, and Paris to ferret out the passage in Monge in which it occurs, and very diligent search was made, as well in the printed works as in the manuscripts of Monge in the library of the Institute, to accomplish this object.

But all these researches were fruitless, and the opinion was come to by the compatriots of Monge that Boole had made a misquotation, and that the formula ascribed by him to Monge was not to be found in his works. The formula is one of very great interest, as being the first instance on record of a multinomial projective reciprocant.

Knowing how scrupulous and painstaking Boole was, and the least likely of all men to make a quotation at random, I never acquiesced in this belief, but entertained little or no hope that any one would ever succeed in unearthing a reference which had defied all the endeavours of Monge's own countrymen to verify.

But fate had designed otherwise, as will be seen from the subjoined letter. In addition to the satisfaction of a controverted point being settled and Boole's character freed from a rash imputation of inaccuracy, it is to my mind, and will probably be so to many of the readers of NATURE, a peculiar source of pleasure to contemplate the occurrence as an illustration or note of the unity not merely of occupation, but of feeling also, which binds together mathematical workers in all parts of the world.

To think that a task found impossible in London and Paris should have been accomplished in the most satisfactory manner at Yale and Michigan!

Without further comment I submit the letter in its entirety as written, for the insertion which it so well merits in the world-wide-diffused columns of NATURE, and think that all its readers will join with me in according a cordial vote of thanks to Prof. Beman for his valuable contribution to mathematical history.

University of Michigan, Ann Arbor, Michigan, April 3, 1886

PROF. J. J. SYLVESTER, Oxford, England

DEAR SIR,—You will find Monge's form of the differential equation of the conic in his memoir, "Sur les Équations différentielles des Courbes du Second Degré" (Corresp. sur l'École Polytech. Paris, ii., 1809-13, pp. 51-54), and in *Bulletin de la Soc. Philom.*, Paris, 1810, pp. 87, 88; the first as having been contributed directly by Monge, and the second as having been copied from the first.

I have not *seen* the journals myself, but the references have been *verified* for me at the Yale College Library. The actual form is "$9q^2t - 45qrs + 40r^3 = 0$."

The term "Mongian" can now be used without hesitancy by you.

I remember noticing this form when I began reading Boole's "Differential Equations," and I also noticed Halphen's method in Jordan's "Cours d'Analyse." It never occurred to me that Halphen considered the *form* original with himself; I thought that his *method*, probably, of deducing it was different from Monge's.

With kind recollections of having met you at Johns Hopkins once upon a brief visit when Prof. Cayley was there,

I am yours very sincerely,
W. W. BEMAN,
Assoc. Prof. Math.

Since writing the above, in fact this very afternoon, I have received a letter from the Universal Knowledge and Information Office containing the same references as those given by Prof. Beman, which will speak for itself, and cannot fail to draw the attention of the readers of NATURE to the important service which this Society is capable of rendering to all engaged in research of whatever nature in enabling them to discover the origins and hunt up the authorities of any subject on which they may desire to obtain information.

It is certainly a singular coincidence that after the lapse of four months the desired information in this case should have reached me from such widely distant sources at an interval of less than forty-eight hours. The letter, which I inclose, is well deserving of setting out in full. The reference made to the circle at the end is extremely interesting, as it contains an example of a non-homogeneous mixed reciprocant, which in the notation now in use might be written $(1 + t^2)b - 3ta^2$. Or rather, adopting the improved notation, in which $t, a, b, \ldots$ represent

$$\frac{dy}{dx}, \quad \frac{1}{1.2}\frac{d^2y}{dx^2}, \quad \frac{1}{1.2.3}\frac{d^3y}{dx^3}, \ldots$$

it takes the form

$$(1 + t^2)b - 2ta^2.$$

London, April 15, 1886

DEAR SIR,—I am instructed by the management to send you the following in reference to your question relating to the attribution of the differential equation

$$\left(9\left(\frac{dy}{dx^2}\right)^2 - 45\frac{d^2y}{dx^2}\cdot\frac{d^3y}{dx^3}\cdot\frac{d^4y}{dx^4} + 40\left(\frac{d^3y}{dx^3}\right)^3 = 0\right)$$

to Monge by Boole in his "Differential Equations."

In the *Nouveau Bulletin des Sciences, par la Société Philomathique de Paris*, tome ii., Paris, 1810, occurs this passage:—

"Mathématiques.—Sur les Équations différentielles des Courbes du Second Degré, par M. Monge. L'équation générale des courbes du second degré étant

$$Ay^2 + 2Bxy + Cx^2 + 2Dy + Ex + 1 = 0,$$

dans laquelle A, B, C, D, E sont des constantes, M. Monge donne l'équation différentielle débarrassée de toutes ces constantes, et il parvient à l'équation suivante, du cinquième ordre,

$$\text{(A)} \qquad 9q^2t - 45qrs + 40r^3 = 0,$$

les quantités r, s, t, étant définies par les équations suivantes:

$$\frac{dy}{dx} = p, \ \frac{dp}{dx} = q, \ \frac{dq}{dx} = r, \ \frac{dr}{dx} = s, \ \frac{ds}{dx} = t.$$

"Il faut ensuite voir l'usage de l'équation (A), pour trouver l'intégrale d'une équation d'un ordre inférieur qui satisfait à cette équation (A); ainsi étant donnée l'équation différentielle $(1 + p^2)r = 3pq^2$, il parvient à l'intégrale $(x - a)^2 + (y - b)^2 = c^2$, qui est l'équation d'un cercle.

"La même méthode pourroit s'appliquer aux équations des courbes d'un degré supérieur au second."

A note is added to the effect that "Cet article est extrait de la Correspondance de l'École impériale Polytechnique, rédigée par M. Hachette: 1r cahier du 2e volume, 1810." The press mark of this work at the British Museum is PP. 1543.

Trusting that this is the reference you are in search of, and that the long delay in the discovery of it may be excused when the difficulty of identifying a particular passage (known perhaps only in its full extent to those whose chief work is concerned with such matters) is considered.

I remain, Sir, faithfully yours,
H. FISHER

PROF. J. J. SYLVESTER, &c., &c.

New College, Oxford, April 19 — J. J. SYLVESTER

On the Velocity of Light as Determined by Foucault's Revolving Mirror

IT has been shown by Lord Rayleigh and others that the velocity (U) with which a group of waves is propagated in any medium may be calculated by the formula—

$$U = V\left(1 - \frac{d \log V}{d \log \lambda}\right),$$

where V is the wave-velocity, and λ the wave-length. It has also been observed by Lord Rayleigh that the fronts of the waves reflected by the revolving mirror in Foucault's experiment are inclined one to another, and in consequence must rotate with an angular velocity—

$$\frac{dV}{d\lambda}\alpha,$$

where α is the angle between two successive wave-planes of similar phase. When $dV/d\lambda$ is positive (the usual case), the direction of rotation is such that the following wave-plane rotates towards the position of the preceding (see NATURE, vol. xxv. p. 52).

But I am not aware that attention has been called to the important fact, that while the individual wave rotates the wave-normal of the group remains unchanged, or, in other words, that if we fix our attention on a point moving with the group, therefore with the velocity U, the successive wave-planes, as they pass through that point, have all the same orientation. This follows immediately from the two formulæ quoted above. For the interval of time between the arrival of two successive wave-planes of similar phase at the moving point is evidently $\lambda/(V - U)$, which reduces by the first formula to $d\lambda/dV$. In this time the second of the wave-planes, having the angular velocity $\alpha dV/d\lambda$, will rotate through an angle α towards the position of the first wave-plane. But α is the angle between the two planes. The second plane, therefore, in passing the moving point, will have exactly the same orientation which the first had. To get a picture of the phenomenon, we may imagine that we are able to see a few inches of the top of a moving carriage-wheel. The individual spokes rotate, while the group maintains a vertical direction.

This consideration greatly simplifies the theory of Foucault's experiment, and makes it evident, I think, that the results of all such experiments depend upon the value of U, and not upon that of V.

The discussion of the experiment by following a single wave, and taking account of its rotation, is a complicated process, and one in which it is very easy to leave out of account some of the elements of the problem. The principal objection to it, however, is its unreality. If the dispersion is considerable, no wave which leaves the revolving mirror will return to it. The individual disappears, only the group has permanence. Prof. Schuster, in his communication of March 11 (p. 439), has nevertheless obtained by this method, as the quantity determined by "the experiments hitherto performed," $V^2/(2V - U)$, which, as he observes, is nearly equal to U. He would, I think, have obtained U precisely, if for the angle between two successive wave-planes of similar phase, instead of $2w\lambda/V$, he had used the more exact value $2w\lambda/U$.

By the kindness of Prof. Michelson, I am informed with respect to his recent experiments on the velocity of light in bisulphide of carbon that he would be inclined to place the maximum brilliancy of the light between the spectral lines D and E, but nearer to D. If we take the mean between D and E, we have—

$$\frac{K}{U} = 1{\cdot}745, \qquad \frac{K(2V - U)}{V^2} = 1{\cdot}737,$$

K denoting the velocity *in vacuo* (see *Amer. Jour. Sci.*, vol. xxxi. p. 64). The number observed was 1·76, "with an uncertainty of two units in the second place of decimals." This agrees best with the first formula. The same would be true if we used values nearer to the line D.

J. WILLARD GIBBS

New Haven, Connecticut, April 1

The Effect of Change of Temperature on the Velocity of Sound in Iron

I VENTURE to draw attention to an error relating to the above subject, which, originating with Wertheim, still holds a place in some of our modern books on science. According to Wertheim, the velocity of sound in iron and steel is *increased* by rise of temperature not extending beyond 100° C. Now in no sense whatever is this statement correct. It is true that the longitudinal elasticity of iron, as determined by the static method, will be found greater at 100° C. than at 0° C., provided *we begin with the lower temperature first and the wire has not, after the original annealing, been previously raised to* 100° C.; but the apparent *temporary* increase of elasticity is really a *permanent* one (*Phil. Trans.*, part i., 1883, pp. 129–131), and if the wire be repeatedly heated to 100° C. and afterwards cooled, subsequent tests will always show a *less* elasticity at the *higher* temperature than at the lower, if *sufficient rest after cooling be allowed*. When, however, we come to such small molecular displacements as are involved in the passage of sound through a wire, even the apparent increase of elasticity mentioned above vanishes. I have been able to prove that, when an iron or steel wire is thrown into longitudinal vibrations, so as to produce a musical note, the pitch of this note becomes *lower* as we *raise* the temperature, *even when the wire is heated for the first time* after it has left the maker's hands.

It seems rather strange that this error should have so long been allowed to remain uncorrected, for it has been known for many years that the pitch of a tuning-fork made of steel is lowered by small rises of temperature, and the main part of this lowering must be due to the *decrease* of elasticity of the steel.

HERBERT TOMLINSON

King's College, Strand, April 10

Sound-producing Apparatus of the Cicadas

WITH regard to the above subject, treated of in an article by Mr. Lloyd Morgan in February last (NATURE, February 18, p. 368), I may mention that some time ago I examined the drum of the common cicadas found plentifully in the Himalaya near Simla, and which in the evenings send forth a deafening roar from the rhododendron-trees like the whirr of large machinery. Generally the arrangement of the drum and the powerful muscles was as figured by Mr. Morgan, but I also noticed the following particulars not mentioned by him.

The chitinous rods in the membrane of the drum were not parallel, but converged slightly towards one point of the membrane. The effect of this when the sound-producing motion set in was to cause the membrane to wrinkle sharply towards the point of convergence; and, by experiment on the dead insect with the point of a pencil, it was easy to see that the sound was simply produced by this sharp wrinkling of the membrane. If a piece of stiff paper or parchment be held in the fingers, and the thumb be made to play sharply and rapidly upon it in succession, so as to produce a "kink" or wrinkle each time, a very fair representation of the sound of the insect will be produced. A captive insect, when the motion is slowing down, can be advantageously watched; it will then be seen that, as the sound divides up into separate clicks, the membrane becomes alternately wrinkled and flat. Beyond doubt the sound is no humming.

C. S. MIDDLEMISS

North-West Himalaya, March 14

Ferocity of Animals

I HAVE read with interest the article by Prof. Lloyd Morgan "On the Study of Animal Intelligence" in the present number of *Mind*, in which he touches upon the subject of entangling fact and inference which attracted my attention when reading "Mental Evolution in Animals" some time since.

I write to call Prof. Morgan's attention to the excellent example of "ejective inference" given by Dr. Romanes in his letter in NATURE for April 1 (p. 513), where he says of a rat that he "perfectly understood my object." Would it be troubling Dr. Romanes too much to ask him to explain the appearance a *wild* rat presents on "perfectly well understanding" the object of a human being's actions?

Churchfield, Edgbaston, April 5 F. H. COLLINS

Tropical Dew

HAVING had occasion to lay out a large quantity of iron hoes and picks, without handles, on the hard ground of an open inclosure in one of the driest districts in India (Bellary), where, in fact, these implements had been collected in the face of a scarcity, it was found, after they had lain a couple of months, that a thick, weedy, but luxuriant vegetation had sprung up, enough, though there had been no rain, to almost hide the tools.

The effect depositing tools on grass has had in stimulating its growing the writer has observed in the tropics before, but was at a loss to account for it, except upon some irresolvable theory of radiation or magnetism.

The whole phenomenon is cleared up by Mr. Aitken's paper on "Dew" in NATURE of January 14 (p. 256), dew being proved deposited, not, as generally thought, from the air above, but rising and condensing from the soil below; and the ground in India is always hygroscopic. The outer surfaces of the iron tools radiate of course quickly at night, and the stratum of air inclosed between the metal under surfaces and the earth is therefore saturated with condensing moisture.

That iron gratings laid on bare ground will raise a rank vegetation in places with only 10 or 15 inches of annual rainfall, and exposed to tropical heat, is a not unimportant fact, as being a readily available substitute for irrigation water, worth further investigation.

A. T. FRASER

India, March 26

The Climbing Powers of the Hedgehog

I AM advised by some of my friends to send you a notice of the mode in which hedgehogs may frequently escape from confinement, and of their habits.

I obtained a hedgehog last week, and put it in my kitchen. Every day it is placed in a small back area, about 12 feet square, during the day-time. The waste-pipes from the cisterns discharge into this area, and the animal frequently lies under these, and, as my servant says, "wallows in the trough like a pig." If he hears any noise he at once runs to a corner and rolls himself up.

On Wednesday the servant found him on the top of the partition wall between my area and the next. This wall is vertical, height 9 feet 6 inches. The top course but one projects 1 inch, so he must have climbed over this.

He has been watched in the operation. He climbs by the projecting mortar beds, which are rather rough, looking about him frequently to see if he is watched. He climbs up the house wall beside the pipe in the corner—an ordinary iron rain-pipe; but from the shoulder of the pipe, where it passes through the wall, to the top of the partition wall, there is a distance of 9 inches without any pipe, so up this portion and over the projecting brick course he must have climbed by clinging to the wall of the house or the partition wall.

Yesterday (Thursday) he repeated the ascent, and descended into the next area, where he was found this morning.

ROBERT H. SCOTT

6, Elm Park Gardens, April 16

STARS WITH BANDED SPECTRA[1]

THE spectroscopic survey of the northern heavens, undertaken conjointly by MM. Vogel and Dunér in 1879, has already progressed so far that its general results can be fairly anticipated—its immediate results, that is to say; for it is ultimately designed, not so much for a collection of statistics, however valuable and interesting, as for a criterion of change. This effect, however, must wait for the future—perhaps a remote future—to develop; we can in the meantime gather much present knowledge through labours inspired by still unfolded possibilities.

The first instalment of the first spectroscopic star-catalogue systematically executed, was published by Vogel in 1883 (*Publicationen* des astrophysikalischen Observatoriums zu Potsdam, No. 11). It covers a zone of the heavens extending from $-2°$ to $+20°$ of declination, and includes 4051 stars down to 7·5 magnitude. M. Dunér now sends us from Lund, in a catalogue of 352 stars fully ascertained to possess spectra of the fluted and zoned types, a work of special and extreme importance.

Stars with banded spectra fall into two perfectly distinct classes, of which the first is well exemplified in α Orionis (Betelgeux), the second in a 5·5 magnitude star close behind the Great Bear, numbered 152 in Schjellerup's Catalogue of Red Stars (*Astr. Nach.*, No. 1591), and called by Father Secchi "La Superba," from the extraordinary vivacity of its prismatic rays. The spectrum of Betelgeux (Fig. 1) shows a series of seven or eight well-marked dark bands (besides minor shadings) all abruptly terminated towards the violet, and dying out by insensible gradations towards the red. The impression upon the eye resembles that of a colonnade thrown into strong relief by a vivid side-illumination. Only three conspicuous dark spaces, on the other hand, interrupt the beams of 152 Schjellerup (Fig. 3); but their breadth is fully twice that of the flutings in the spectrum of α Orionis; and, still more remarkable, they *face in the opposite direction.* Their obscurity deepens slowly downwards towards their less refrangible sides, then suddenly, by a sharp transition, and with a singular and splendid effect of contrast, gives place to unclouded light.

The stars characterised by these two different qualities of absorption, respectively constituted Father Secchi's third and fourth spectral orders. M. Vogel, however, saw fit in 1874 (*Astr. Nach.*, No. 2000) to modify the arrangement by grouping the two varieties together as subdivisions of a single class. Nor was this a mere arbitrary change. It was the outcome of a far-reaching speculation regarding the course of development taken by the great army of suns marshalled in the profundities of space.

Secchi's classification involved no hypothesis of any kind; it was founded simply on appearances. But the idea that the colours, consequently the spectra of stars, may guide us to a knowledge of their comparative "ages," thrown out in a crude shape by Zöllner in 1865, had, meantime, made its way. Vogel's adoption of it as a means of rationalising observed particulars, gave it (perhaps prematurely) a recognised scientific status.

According to this view, the white stars forming Secchi's first order (of which Sirius and Vega may be taken as

[1] "Sur les Étoiles à Spectres de la Troisième Classe." Par N. C. Dunér. Mémoire présenté à l'Académie Royale des Sciences de Suède, le 11 Juin, 1884. (Stockholm, 1884.)

representative), are in the initial stage of their life as suns. Their energy is still unwasted; their temperature is enormously high; their light is not sensibly modified by absorption, hydrogen being the only constituent of their atmospheres capable of strongly intercepting their radiations. But with the lapse of ages, this early fervour cools down, and absorption gains strength. Hydrogen no longer stamps itself predominantly upon their spectra; metallic rays deepen and multiply; a dusky veil is drawn across each photosphere, stopping preferentially its more refrangible emissions, and thus imparting a yellowish tinge to the resulting light. The condition of our sun, as well as of Capella, Pollux, and Dubhe, is, in short, reached. Down to this point the history of all ordinary stars is the same. Here, however, a bifurcation in the path of development is reached. Two roads to extinction are now open to them. For, according to Vogel, the two varieties of banded spectra mark co-ordinate, not successive, stages in stellar existence. The choice, so to speak, once made, is definitive. Migration from one type to the other is impossible. Hence Vogel's abolition of Secchi's fourth type, and his distribution of such stars as Betelgeux and α Herculis on the one hand, and 152 Schjellerup and 19 Piscium on the other, into two alternative branches of his third. But let us look a little more closely at facts before admitting conjecture.

M. Dunér's Catalogue includes 297 entries under the heading Class III. *a* (type of α Orionis), to which in all 475 stars are so far known to belong. A particular description of each spectrum, from his own and others' observations, is appended; so that ample materials are provided for some few safe generalisations.

The first point to be noted is that the positions of the leading bands in *all* spectra of this kind are absolutely unchanging. The series is repeated with varying degrees of intensity from star to star, almost as if in stereotype. The shadings are, it would seem, in reality made up of fine lines very closely grouped. D'Arrest and Huggins, at least, repeatedly succeeded in thus resolving them, although to Vogel, even when employing most powerful optical means, they persistently maintained a nebulous appearance. Now a glance at the accompanying figures will show a symmetry in the arrangement of these bands suggesting that they result from the rhythmical vibrations of one highly complex molecular system. In other words, they betray the absorptive action of a single substance; particular identification is awaited; nor is it easily attainable. Great difficulty attends inquiries into the direct spectra of compound bodies, since the very means employed to render them luminous, also tend to destroy, by forcing them asunder into their constituent elements.

Besides this unknown substance, however, metallic vapours exist abundantly in the atmospheres of Betelgeux and its congeners. The grooved spectrum distinguishing them might in fact be regarded as superposed upon a modified Fraunhofer spectrum. Not only in its bright spaces, but even across its dusky flutings, a crowd of significant dark rays can be perceived. Their number, as disclosed by the 27-inch Vienna refractor in September, 1884, in the spectra of β Pegasi and α Herculis, took Vogel altogether by surprise (*Publicationen*, Potsdam, No. 14, p. 22). Yet he and Dr. Huggins had already measured no less than 95 such in the analysed light of Betelgeux. Some of these can be identified with terrestrial substances. Sodium, iron, magnesium, calcium, and bismuth, are without doubt incandescent above the photosphere of that star. Lines of hydrogen have also been made out, and its presence is certified by Dr. Huggins's photographs. Its absorption is, however, inconspicuous in all, and imperceptible in most spectra of this description.

One of their most singular features, as yet unexplained, is that dark metallic rays form the sharp boundary of many of the flutings. Thus calcium-lines (wave-lengths 616·4 and 585·6) respectively terminate, on their more refrangible sides, the bands numbered 2 and 3 in the figure; strong contiguous lines of calcium and iron limit band 4; band 5 ends with the well-marked iron lines of wave-lengths 545·0 and 544·4, and band 8 with that of 495·8; band 7 with the solar group *b*; band 9 with a deep furrow of unknown origin. These coincidences are extremely puzzling; for, as M. Dunér remarks, they can scarcely be accidental.

Stars with fluted spectra are all more or less deeply tinted with orange, owing to the stoppage, by a general absorption, of by far the greater part of their blue rays. Their actual emissions must then be very greatly in excess of those reaching outer space. Stripped of its surrounding atmosphere, our sun, it is computed, would leap up to some three or four times its present lustre; but in stars like Betelgeux, absorption must at least quadruple its solar effects. This consideration is of fundamental importance in any estimate of the relative luminous power of the stars.

Fifty-five members of Class III. *b* find a place in the Lund Catalogue. These are all that have hitherto been discovered. Yet exploration, in their case, is more complete than with the previous type, the broad, deep zones of their spectra being distinguishable in objects much too faint to show the narrower groovings of Class III. *a*. No star of this kind is as bright as the fifth magnitude, while eight between ninth and tenth are included in M. Dunér's list. Thus, although the fluted spectra already examined outnumber those in zones (as we may call them for the sake of distinction) scarcely nine times, M. Dunér considers that the real proportion of their excess is at least fifty to one.

The rare objects constituting Class III. *b* are amongst the most interesting in the heavens. For they exhibit in their spectra the unmistakable signature of that substance which, more than any other, deserves to be called the material basis of life. Father Secchi (their original discoverer) regarded them from the first as "carbon-stars;" but Dr. Huggins in 1872 tested the supposition (for it was then little more), and rejected it as disproved. There is now no doubt that the Roman observer was in the right. The three conspicuous bands of dense absorption visible in such spectra agree in position quite closely with the emissions of carbon-vapour glowing in the electric arc. Dr. Huggins gives scanty details of his observation (see Schellen's "Spectrum Analysis," ed. 1872, p. 504); he is rarely in error; but on this occasion was perhaps misled by the facile emergence of acetylene-bands, of which the blue one falls just in the intermediate position indicated by him as fatal to the suggested identity.

Besides carbon, sodium is without doubt present in the atmospheres of these remarkable bodies; and there are signs of further metallic absorption, notably by iron. Their rays being, however, too faint to bear scrutiny with a narrow slit, the finer features of their spectra remain, for the present, unrecognisable. Yet we cannot avoid being struck with the circumstance that their most prominent constituent elements are precisely those which kindled in the great comet of 1882 as it approached the sun.

The "zoned," like the "fluted" stellar spectrum, is, in general outline, invariable, though capable of endless individual modifications of tone and detail. It is as if one fundamental sketch-plan were filled in with the most diverse depths of shading.[1] Another point on which all such stars agree, is the redness of their light. The violet end of their spectra is, uniformly, all but obliterated; not necessarily through original deficiency. The more refrangible emissions of 152 Schjellerup may, for aught we

[1] See Figs. 4, 5, and 6; the last a supposed example of a "transition" spectrum given by a star in course of passing from Class II. *a* (solar type) to Class III. *b*.

can tell, be as copious as those of Sirius or Vega. But they are intercepted in a deeply-laden atmosphere, which can indeed be escaped by only a small per-centage of their entire radiations. This explains at once the uniform inconspicuousness of such objects. A star of this class should possess, say, a hundred times the radiating surface of Vega, to send us, from an equal distance, the same quantity of light.

No star of those yet known to show banded spectra of either kind has an ascertained parallax. This is not wonderful, since the stars at measured, or perhaps measurable, distances from the earth, constitute a scarcely perceptible fraction of the whole. Still, the fact remains that all members of the two classes under consideration are indefinitely remote. We are accordingly without the means of estimating, even in the most general way, the real quantities of matter contained in, or of light emitted by, them. We can only say that their dimensions must be very great in proportion to their apparent magnitudes.

The question of their distribution is of much interest, as involving their relations to the vast ground-plan of the sidereal system. And one circumstance connected with it becomes immediately evident. This is, their largely predominant occurrence in and near the plane of the Milky Way. M. Dunér, it is true, considers that they merely obey the general law of stellar condensation. But this law applies more and more closely to the lessening orders of stars; and we have just seen that, physically, stars characterised by strong absorption should rank with stars optically by many degrees their superiors. The hypothesis, then, of some special connexion with the galactic streams and rugosities is by no means excluded; and it is countenanced by statistics as to the distribution of red stars in the southern hemisphere, recently afforded by M. Pechüle ("Expédition danoise pour l'Observation du Passage de Vénus," 1882, p. 38).

One of the most assured peculiarities of stars with banded spectra is their marked tendency to fluctuations of light. Amongst innumerable examples of this connexion may be cited "Mira" Ceti, and Gore's "new star" in Orion, both of which display brilliant prismatic flutings. Nearly all variables, in fact, save the few which complete their cycle of change in a few days, belong to one or other of the subdivisions of Class III. Whatever may be the secret of their constitution, it is indissolubly bound up with the still mysterious cause of stellar variability. We can scarcely penetrate the one without divining the other. Already something is gained by the mere fact of the connexion being established. We learn from it that the steadfast shining of a sun or star is conditioned by the quality of its surrounding gaseous envelope. Continuous study, then, of the spectra of variables affords probably the best chance of progress in knowledge of their nature. M. Dunér's incidental observations show that the reinforcement and extension of banded absorption apparent at minima, do not sufficiently explain the diminution of light, which must accordingly be in part due, either to a real failure of emissive power, or to an increase of general absorption. The analogy of sun-spots favours the latter alternative.

M. Dunér concludes his valuable memoir with the admission that the order of stellar development postulated by Vogel, and advocated by himself, may, after all, be the inverse of that pursued in nature,—a possibility surely worth thinking about.

The heavens are no longer in our eyes "incorruptible." Reason and revelation alike lead us to seek for symptoms of growth and decrepitude in their bright inmates. Not in human affairs alone "the old order changeth, yielding place to new." But the subject is one on which we are without the guidance of experience, and can scarcely hope to acquire any, regard being had to the almost infinite disproportion between our hurried notions of time, and the unimaginable leisureliness of cosmical progression. Caution is then all the more needful, if we would avoid wide wandering from the truth.

Now it has to be objected to Vogel's scheme, that it gives no account whatever of suns in process of becoming. Yet they must be as numerous, one would think, as suns in process of decay. From the summit of brilliancy and vigour, the course of decline is traced downward towards the final quenching. But what of the other branch of the curve? Stars now at their acme of splendour must have passed through long periods of preparation. Sirius and Canopus, we are fully assured, did not all at once blaze out in their present radiance. What, then, we cannot abstain from asking, was their anterior condition? What quality of light did they emit? How were their atmospheres constituted? What kind of spectra, in short, would they then have afforded? A system of classification, based on the supposed order of stellar development, in which no account is taken of this wide branch of the inquiry, must be regarded as essentially incomplete.

A. M. CLERKE

THE INSTITUTION OF NAVAL ARCHITECTS

THE twenty-seventh annual session of the Institution of Naval Architects, held at the rooms of the Society of Arts, was one of the most successful of the series. The meetings began on the 14th inst. and concluded on the 17th. There were seven sittings, averaging from three to four hours each, and no less than eighteen papers were read and discussed. As on previous occasions, too much was attempted to be done in the time available, with the result that some important matters received scant notice. This may be to some extent inevitable in a Society embracing such wide and varied interests, yet meeting but once a year. But it may be anticipated that the autumn meetings in the outports which are now contemplated may somewhat relieve the congestion in future.

Lord Ravensworth presided as usual, and delivered a Presidential Address, in which various matters of interest were touched upon, *inter alia* the use of liquid fuel instead of coal in steamships, the development of triple-expansion engines, the prospects of shipping and the statistics of shipbuilding, including the extended use of steel. It may be hoped, although the immediate future scarcely justifies the expectation, that before the next meetings a change in circumstances may enable the President to speak more cheeringly. On the other hand, it is an undoubted fact that the period of depression through which the country is now passing is forcing into prominence inquiries into possible economies in the construction and propulsion of ships which might otherwise have been neglected.

No less than seven of the papers read had relation to the propulsion of steamships. The first on the list—"On the Speed Trials of Recent War-Ships"—was read by Mr. W. H. White, Director of Naval Construction. It contained a succinct account of the remarkable advances made during the last quarter of a century in the speeds and propelling machinery of war-ships. The fact that huge battle-ships carrying enormous weights of armour and guns are now driven at speeds of 17 to 18 knots—20 to 21 miles per hour—is sufficiently remarkable. Yet the fact that such a ship, weighing 10,000 tons, can be driven 9 knots in an hour with an expenditure of only 1 ton of coal is no less striking. Much has been learnt, too, of late years as regards the influence of *form* upon the resistances of ships; thanks, in great measure, to the researches of the late Mr. Froude, whose work received the substantial support of the Admiralty. In the paper above mentioned it was shown that by suitable selection of form, the *Howe*, a vessel of 9600 tons, 325 feet long and 68 feet broad, was driven as easily as the *Warrior* up to the highest speed reached by the latter, although she was 380 feet long, 58 feet broad, and of 8850 tons only. The *Warrior* reached 14½ knots only; the *Howe* attained 17 knots. Improvements in marine engineering made this tremendous speed possible in the *Howe*. In her each ton weight of propelling apparatus corresponded to 10 indicated horse-power; in the *Warrior* 6 indicated horse-power required 1 ton. This economy of weight in the propelling apparatus was shown to be due to several causes, including a higher steam-pressure, quicker-running engines, the use of forced draught in the stoke-holds, and the introduction of wrought iron, steel, and gun-metal instead of cast iron.

Two papers dealt with the interesting subject of "forced draught" from different points of view. Mr. Sennett described at some length the Admiralty system of "closed stoke-holds," by means of which air is delivered into the boiler-rooms by powerful fans, and at a sensible pressure. The stoke-holds being thus *in plenum*, the air can escape only through the furnaces, and combustion is quickened greatly. With the best *natural* draught, about 10 indicated horse-power per square foot of furnace (or grate area) is considered a good performance: with forced draught and closed stoke-holds, this may be increased from 60 to 80 per cent. It will be seen therefore that for war-ships, which only require to steam occasionally and for comparatively short periods at full speed, the system is admirably well adapted. And it has been proved to be not nearly as wasteful of fuel as might have been supposed; while it certainly makes the stoke-holds cooler and more comfortable to work in. For the mercantile marine the conditions are different: ships have to steam ordinarily at practically their full speed; the restrictions of weight and space are not so great as in war-ships; and economy in coal consumption is of primary importance. Still even here forced draught promises to supplant natural draught, and to enable large economies to be made in weight and size of boilers concurrently with savings in coal. Mr. Howden described his system of forced combustion, which has been tried at sea over a long period, and promises to be successful. He does not close in the stoke-holds, but delivers air under pressure from fans direct into the furnaces and ash-pits, this air having been heated by passing through a special apparatus placed in the up-takes. Great economy is claimed for this system, and it was well spoken of by competent authorities in the discussion which followed. Competing plans are also being tried, so that more will certainly be heard of forced draught in the mercantile marine. Hitherto economy has been sought in higher pressures and in the *use* of steam in the engines: now engineers are turning attention to the boiler, and the means of generating steam with a minimum expense.

Hard times in the mercantile marine have led to a wholesale conversion of compound engines into engines of the triple or quadruple expansion type. Mr. Cole read a thoughtful and well-considered paper on this subject, which is of general interest to shipowners just now. It may prove a very desirable thing to reduce the coal-bill by 20 per cent., even at the cost of converting the machinery to the more highly expansive type.

It is a natural transition from the propelling machinery to the propellers of steamships. Mr. R. E. Froude, who has succeeded his father in the superintendence of the Admiralty model-experimental works, contributed one of the most valuable and scientific papers read at the meetings, on "The Determination of the most Suitable Dimensions for Screw Propellers." He attempts from experiments with models of ships and screws to ascertain the resistance experienced by a ship moving at a given speed, and the "augment" of that resistance produced by the action of the propeller behind her. By means of a lengthy series of experiments with model screws he further attempts to fix the best diameter and pitch for a given number of revolutions of the engines. And finally, the results are thrown into a form adapted for practical use. The paper is in all respects admirable, but we are bound to say that it can be regarded only as another step forward on a very difficult road, and may be treated as provisional rather than conclusive. Some of the inferences do not accord, either, with the results of general experience. It is to be welcomed, however, for as yet the theory of the screw propeller is not in a satisfactory condition; and it is well known that very remarkable economies are frequently realised by changes in propellers. In the course of the discussion Mr. White mentioned a case of recent occurrence, where, by a change of screw only, the speed of a ship was raised from 12 to 13¼ knots per hour.

M. Marchal, of the French Génie Maritime, contributed an interesting paper, in which the results of a number of experiments, made by order of the Government, were described. It was desired to obtain data for guidance in deciding on the relative advantages of two or three screws as applied to an ironclad of 10,000 tons. A model steamer of 10 tons was built, and tried at "corresponding speeds," with two screws and with three. The publication of this paper marks a distinct change of policy in France, and it places before English designers a mass of valuable facts, which may prove very useful hereafter as the speeds of ships are increased.

Mr. Hall read a paper on "Flexible Shafting for Screw Steamers," describing a plan by which he hopes to reduce the number of breakages or serious accidents to the screw shafts of ocean-going steamers. His contention was that in not a few cases there is a want either of accuracy in the line of shafting and shaft-bearings, or of rigidity in the hulls of steamships; so that, by special joints between the various lengths of shafting, a certain amount of flexibility might advantageously be secured. Experience will prove whether he is correct or not in the anticipation that his plan will reduce accidents or breakages—serious matters in single-screw ships carrying large numbers of passengers and having very small sail-power.

Another important group of papers are those dealing with the use of rolled and cast steel for shipbuilding. It is well known that steel is rapidly gaining upon iron, and Mr. Martell (of Lloyd's) stated some very interesting facts as to the extension of its employment in the mercantile marine. War-ships are now all steel-built. Seven years ago only 4470 tons of steel ships were built as against 518,000 tons of iron ships. In 1885 over 165,000 tons of steel ships were built as against 290,000 tons of iron. Confidence in steel was expressed by Mr. Martell in his paper, echoed by Mr. Ward in another excellent paper recording eight years' experience in building steel ships, and indorsed by all who took part in the discussion. Incidentally the question arose of the introduction of steel made by the "basic" process for shipbuilding purposes; as yet this "make" of steel has not found much favour, but the Admiralty authorities are now about to undertake a series of experiments from which much may be learnt. Every one agrees that thorough and systematic testing has done much to secure the excellent qualities of steel now made by both the Bessemer and the Siemens processes; and even the manufacturers are in favour of maintaining the full severity of the tests in order to prevent any deterioration in quality. Of more recent date than the use of "mild-steel" plates and bars is the introduction of mild-steel castings in lieu of iron forgings. Mr. Warren, who had been chairman of a Committee appointed by the Admiralty to look into this question, gave to the meeting an excellent summary of the results of their inquiries. There can be no question but that heavy iron forgings are doomed to give place to steel castings, which can be produced rapidly and cheaply, of sound and ductile quality, and in finished forms, avoiding costly machine-work. As a record of experience up to date, Mr. Warren's paper will have a permanent value.

The remaining papers on the list are of a miscellaneous character, but all of considerable interest. Mr. Heck described a "Mechanical Method of Finding the Stability of a Vessel," by means of a simple model. This is a very ingenious and labour-saving device, likely to prove of great assistance in ordinary ship-yards, where a staff of trained calculators may be wanting. Mr. Stromeyer described a "Strain Indicator" which he has invented. This instrument is extremely simple in its construction: the essential parts consisting of two flat plates between which is inserted a "rolling-pin" of fine steel wire. Relative motion of the two plates causes the rolling-pin to rotate, and its rotation is the means of measuring the strain to which the material is subjected in any portion of a sample or a structure to which the indicator may be attached. If this instrument answers as well as it promises to do, much will be learnt from its indications as to the strains brought upon ships under various conditions and more especially at sea. Such information carefully compiled and collated ought to prove of value in determining the structural arrangements of ships.

Admiral Paris, the venerable Curator of the Naval Museum at the Louvre, long known for his eminence as a scientific naval officer and as an archæologist in ship-building, attended the meetings, and contributed an interesting paper on the "Rolling of Ships," exhibiting an instrument designed to represent the relative movements of ships and waves. His reception was deservedly cordial.

Capt. Colomb described, in a well-written paper, some of the more important results of recent measurements of turning powers of ships in the Royal Navy. These trials are now systematised, and much has been learnt from them which will be of value to future naval tactics, as well as useful to shipbuilders in designing rudders and steering-appliances. A novel steering-gear was described by Mr. Maginnis, who also laid before the Institution some valuable autographic information on the obscure subject of the strains brought upon a rudder when it is "put over" to various angles in a ship moving at speed.

Mr. Read's contribution, "On the Strength of Bulkheads" in ships, was seasonable, the recent loss of the *Oregon* having again drawn public attention to the necessity for water-tight subdivisions as a means of safety from foundering. Mr. Read put into a mathematical form the principles which should regulate the construction of bulkheads if they are to successfully withstand the water-pressure which must come upon them when the compartments are "bilged" and sea-water enters. He did not deal with the principles which should govern the disposition of bulkheads; but these principles are well understood, and more generally acted upon now than formerly.

Another paper by Mr. Benjamin described a "Proposed Steam Lifeboat" which had been designed to be practically uncapsizable; and for that purpose, among others, made of a very peculiar form. The only other paper on the list described the improved methods of working anchors and cables devised by the author, Mr. Baxter. This was a paper of a practical and historical character, on a subject of undoubted importance.

From this hasty summary it will be seen that the Institution of Naval Architects maintained at its recent gatherings its old reputation for widely diversified topics of discussion. And it is to be added that the papers as a whole, numerous as they were, were also of more than average merit.

ON THE USE OF MODELS FOR INSTRUCTION IN THE MAGNETISM OF IRON SHIPS

THE deviations of the compass produced by the iron used in the construction of wooden ships was a source of considerable perplexity to the navigators of the last and early part of the present centuries; and no sooner were these difficulties fairly overcome than the building of ships entirely of iron commenced.

With the introduction of iron ships, prolonged investigations into their magnetism and the resulting deviations of the compass on board were undertaken by some of the most eminent philosophers and mathematicians of the day, the subject being still one which occupies the attention of many observers, from the increased use of iron in the equipment, as well as construction, of the hulls and decks. These investigations were much facilitated by the increased knowledge of the earth's magnetism, which received such notable additions from magnetic surveys made by travellers on land and navigators at sea during the years 1819–45.

Moreover, as time rolled on, these observations were embodied in trustworthy graphic representations of the declination or variation, the dip or inclination, and the horizontal force, which have done such good service in the work of obtaining a clear understanding of the cause of the magnetism of iron ships, and the changes to which such magnetism is liable when the vessel's position is altered either geographically or in respect to the magnetic meridian.

It is not here intended to enter into any historical *résumé* of the names of the several investigators in this branch of science, nor of the results which each obtained, but to indicate at once where the physicist and mathematician may find the theory and examples of its application; also, how the practical results of this elegant theory may, by the use of models, be made intelligible and available to the seaman and other inquirers who have neither the time nor the opportunity for abstruse studies requiring considerable mathematical knowledge.

The text-book which is now generally accepted in all countries is the "Admiralty Manual for the Deviations of the Compass," in Appendix No. 1 of which will be found the three fundamental equations of Poisson, which form the whole theory of the deviations of the compass, and the expressions of these equations "in terms of the quantities which are usually given and required," written by the late Archibald Smith, M.A., F.R.S.

The whole of the action of the soft iron of a ship is represented in these equations by the parameters a, b, c, d, e, f, g, h, k, and in a model by nine soft iron rods fixed in definite positions, distinguished by the same letters.

The effects of the magnetism of the hard iron of the ship are represented in these equations by the parameters P, Q, R, and in the model by two permanent magnets held horizontally in definite positions, and a third permanent magnet held vertically under the compass.

One of the most important contributions to magnetical science as regards iron ships was made by Sir George Airy (late Astronomer-Royal) in a paper published in the *Phil. Trans.* Royal Society for 1839. After making a series of experiments in certain iron-built ships, he discussed the results mathematically with the purpose of discovering a correction for the deviation of the compass. He concluded his paper with the announcement of his invention of the system of correction by magnets and soft iron, which is universally practised in the present day, always with advantage, and often as a matter of necessity in ships of certain types, where to find a suitable place even for the standard compass is a matter of no small difficulty. This system of correction, coupled with the analysis described in the "Admiralty Compass Manual," provides the means of correcting a compass even in position on the 'tween decks of our armour-plated ships of war.

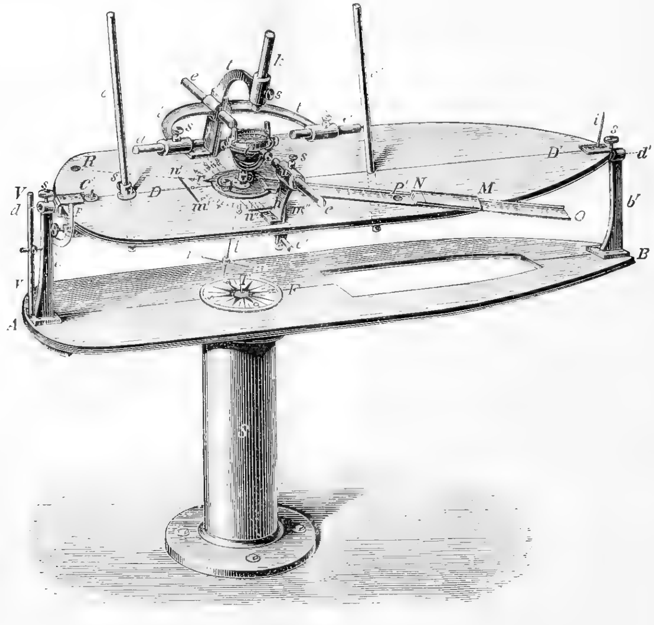
With these preliminary remarks, the description of some different forms of models will be given, and their uses for instruction in the magnetism of iron ships considered.

One of the first of these instructive models was that constructed for Sir George Airy, and used during his lectures to illustrate his method of correction of the deviations of the compass. It consisted of a model of the wooden hull of a vessel. In the centre of the deck a compass was mounted, disturbing magnets and pieces of soft iron being concealed underneath it, producing semicircular and quadrantal deviations as in an iron ship. These deviations were then corrected by placing the model ship with its bow alternately on the north and south magnetic points, when the compass was made to indicate the same directions by means of transverse magnets on the deck; and then on the east and west points magnetic, the correction of the semicircular deviation being completed by longitudinal magnets on the deck. Lastly, with the model placed in a north-east and south-west direction magnetic, scrolls of soft iron were placed on either side of the compass—an imaginary line transverse to the model passing horizontally through the centre of the scrolls and compass-card—until the compass pointed correctly.

Of more recent models there are three which are of an instructive character: one designed by Dr. Neumayer of the German Naval Observatory at Hamburg; the second in England by an official of the Board of Trade; and the third, which is the most complete both for experiments and purposes of instruction, by the United States Navy Department.

The accompanying woodcut on the scale of one-twentieth of the original model is taken from Paper No. 2 of the *Archiv der Deutschen Seewarte*, VI. Jahrgang, 1883, where an account of the experiments to be made with it is given in full detail. The following is a description of the several parts shown.

S is a pillar fixed in the floor of the room, upon which pivots the wooden board A B, with the line of its central



axis marked. At the point T, a compass-card is fixed to S, with its north and south points adjustable in the magnetic meridian.

Supported by the two brass uprights *a' b'*, is the second board in the form of a ship's deck pivoting at *d d'*, so that it can be inclined sideways, as when a ship inclines under pressure of sail or when rolling, but kept horizontal as required by the screws *s s*. An arc, *o p*, marked to degrees, shows the angle of inclination. A gimballed compass, C, with sight vanes, is mounted on the deck, and when the lubber's point and the pin *i* are in line, as seen through the vanes, the compass support is secured by the clamping-screw. O P' is a graduated arm revolving round the base of the compass stand, grooved to receive a bar-magnet, and with a pointer, *r*, showing the number of degrees the arm has been turned in azimuth. *h* and *h'* are brass bearers for carrying the rods of soft iron used in disturbing or correcting the compass, with screws, *s*, for clamping the rods at any required distance.

The model, as described thus far, is entirely free from any magnetic body external to the compass, and may, by means of the latter, be placed with its marked axis in the magnetic meridian, the compass card at T being fixed in that direction for future reference. The means for producing the disturbing forces on the compass similar to those found in iron ships are these. M N is a magnet, which may be so adjusted in the groove that, by moving the arm O P' in azimuth, semicircular deviation of any desired form may be produced. In the figure the magnet M N is placed to produce the semicircular deviation of a ship built with her head north-north-west, and the resulting south (or blue) pole is found in the point R. The soft iron rod V *v* in its vertical position represents the stern-post of a ship, producing that part of the semicircular deviation in compasses placed near it, which changes as the ship moves into fresh magnetic latitudes. cc' are soft iron rods, intended to represent iron masts.

Quadrantal deviation of the form generally observed is produced by the soft iron rod e', extending from side to side under the deck D D′ like a deck beam, the rods $a\,a$ also conspiring with e' in increasing the quadrantal deviation. That part of the heeling error caused by the magnetism of the hard iron of a ship is produced by a small vertical magnet in the position of the rod l when removed; that from soft iron by the vertical soft iron rod k and the horizontal rod e'.

The compass C having been disturbed by magnetic forces of the usual type in an iron ship, may now be corrected: $m''n''$ is a magnet with its north or marked end, n'', towards the stern of the model, and near enough to the compass to correct the deviation on the east and west points: $m'n'$ is a second magnet with its north or marked end, n', towards the port side, correcting the deviation on the north and south points. Or the whole semicircular deviation may be corrected by one magnet, $m\,n$, placed exactly in the direction of R, n being the marked or north end. The quadrantal deviation is corrected by the rods $e\,e$. The heeling error caused by e' is also nearly corrected by $e\,e$, and that caused by the sum of the effects of k and the vertical magnet under the compass by another vertical magnet with the opposite pole uppermost.

Thus it will be seen that any component part of the whole deviation usually found at the standard compass of an iron ship may be produced in the model and the corresponding corrector provided.

The portable model adopted by the Board of Trade has a compass mounted on a ship's deck, as in the figure; but the deck, which rests on a central metal support, revolves round a pivot in the centre of a fixed board, an arrangement for inclining the model being provided.

The disturbing magnets and soft iron are arranged thus. For producing the semicircular deviation due to the hard iron of a ship thin magnets are placed as required in any of the grooves cut in the deck radiating from the centre of the compass, so that deviations due to any direction of the ship's head whilst building may be produced. For that part of the semicircular deviation due to soft iron a vertical soft iron bar is fixed in the central longitudinal line of the deck and near the stern. For the quadrantal deviation hollow cylinders of soft iron are placed under the deck similar to the rod e' of the figure. For the heeling error due to hard iron a magnet is placed vertically under the compass.

The correctors are magnets placed on the deck as $m'n'$, $m''n''$ in the figure, and soft iron spheres—on brass brackets which may be turned in azimuth round the compass—instead of the rods $e\,e$; a Flinder's or vertical soft iron bar before the compass; a vertical magnet under the centre of the compass to correct the heeling error.

This model is exceedingly well adapted for instruction and examination in the causes of the deviations generally found at standard compass positions in the mercantile navy, and the method of correction adopted in that service.

There remains now only the model made for the Bureau of Navigation of the United States Navy Department to be noticed. It consists of a miniature vessel of which the stem, keel, and stern-post are of bronze cast in one piece, with three wooden decks supported by bronze screws. This model, called the *Scoresby*, is pivoted at the stern by a socket in the floor, with a bronze wheel fitted under the bow, so as to be easily turned round in azimuth. The disturbing magnetic forces are produced by magnets and hollow wrought-iron tubes of soft iron, whilst wrought-iron plates can be attached to the sides of the vessel.

The *Scoresby* was designed with the object of proving by experiment the mathematical theory already noticed. Experiments were consequently made as to the effects of hammering the plates of the model with the bow in different directions, a magnetic survey being made after the hammering to determine the polarity in different sections, and its degree of permanency or otherwise. The model was next swung both when upright and inclined, for the deviations of the compass produced by a magnet or soft iron tube representing each parameter singly, combinations being made afterwards as desired. These experimental results proved satisfactorily the correctness of the mathematical theory.

This general description of the *Scoresby* will serve to show that the Americans have taken considerable pains in making valuable experiments in proof of theory, and for instruction to the seaman. Before parting with her, however, a quotation from the American professional paper on the subject of the *Scoresby* seems worthy of a place, as sounding a fresh warning note to those who ruthlessly distribute iron *ad libitum* and in any form round the position of a ship's standard or guiding compass.

"Compensation of large deviations by means of magnets is at the best but a remedy for an ailment; better not sow the seeds of the disease."

The three models just described have been selected as being the most modern specimens of these useful aids to knowledge, but there are others for the instruction of officers in the Royal Navy which have been in use for some years past. It will be gratifying to the many who take interest in maritime affairs to note the increasing anxiety for the spread of a sound knowledge of the principles of the magnetism of iron ships and the deviations of their compasses which the construction of these models manifests.

NOTES

THE total number of candidates for election into the Royal Society this year is sixty-two. Of these the following fifteen have been selected by the Council to be recommended to the Society for election; the voting will take place on June 4:—Shelford Bidwell, M.A., W. Colenso, F.L.S., H. B. Dixon, F.C.S., E. R. Festing, Major-Gen. R.E., Prof. A. R. Forsyth, M.A., Prof. A. H. Green, M.A., Prof. Victor Horsley, F.R.C.S., T. R. Lewis, M.B., R. Meldola, F.R.A.S., P. H. Pye-Smith, M.D., H. C. Russell, B.A., Prof. W. C. Unwin, B.Sc., R. Warington, F.C.S., Capt. W. J. L. Wharton, F.R.A.S., and H. Wilde.

THE following are the probable arrangements for the Friday evening meetings of the Royal Institution after Easter:—May 7, Mr. Frederick Siemens, "Dissociation"; May 14, Prof. John Millar Thomson, F.C.S., "Suspended Crystallisation"; May 21, Sir John Lubbock, Bart., M.P., F.R.S., "The Forms of Seedlings: the Causes to which they are due"; May 28, Prof. Oliver Lodge, D.Sc., "Electrical Deposition of Dust and Smoke"; June 4, Walter H. Gaskell, M.D., F.R.S., "The Sympathetic Nervous System"; June 11, Prof. Dewar, M.A., F.R.S.

THE editor of the *Sidereal Messenger* (U.S.) writes in his April number:—"We are glad to learn from private advices that a small observatory will soon be fitted up with the necessary instruments for continuous solar and local magnetic observation, in which daily solar photographs of the sun will form an important part of the work done by the observers. We are not aware that work of this kind is now anywhere systematically undertaken in the United States."

THE Congress of French Sociétés Savantes will take place as usual at the Sorbonne, and the final ceremony under the chairmanship of M. Goblet, the present Minister of Public Instruction. It is expected that this ceremony will have an unusual interest, M. Goblet having sent a circular to the various learned Societies, announcing his intention of altering the date of the Convocation of French *savants* in Paris.

ALTHOUGH the Association Française and the Société Scientifique de France have passed a vote for their fusion into one compact body, the resolution has not been carried into effect, owing to some legal difficulties resulting from the very peculiar state of French law relating to Societies of public interest, which are considered as so many infants, whose properties are always in the hands of a lord chancellor for protection.

THE Report of the Committee of the Mitchell Library at Glasgow (where the Public Libraries Act was rejected by a moderate majority during the past year), while showing a largely-increased usefulness of that institution, forces attention to the very great cost of working even a reference library only. Out of an expenditure of 2770*l.*, only the odd 770*l.* can be employed in the combined purchase and cost of binding of both books and periodicals. Of this, 450*l.* is all that was spent in the purchase of 4500 publications; which does not suggest costly works for a reference library from which fiction is excluded. Nevertheless, the crowded state of the present rooms has led to an earnest effort to expend nearly fifty times that amount in a new site and "inexpensive" buildings, although the Committee are well aware that "a new and large building would imply a larger annual expenditure of every kind." The present premises have been much more economically, though not sufficiently, supplemented by the addition of two small houses adjoining, in one of which a reading-room for ladies has been fitted up, while the remaining rooms are well utilised by being shelved and filled with the less-used classes of literature. Complete sets of the 268 periodicals taken would be a valuable part of such a library if indexed in the American way, so that all the most recent information would be found there directly or indirectly. A presentation of 288 volumes from the Lords of Her Majesty's Treasury is specially acknowledged, and suggests that a gift from Government Offices of sets of their publications to all free libraries up to a certain time, which would be willing to properly house them, would be no very great cost to the nation, while it would be a reward to the enterprise of those towns which have organised free libraries and an encouragement to others to do so quickly.

THE Fish Commission steamer *Albatross*, *Science* states, arrived at Nassau, New Providence, March 19, after a most successful trip. The ship was chiefly engaged in making soundings. Two naturalists were landed at Watling's Island, San Salvador, where much valuable scientific material was gathered during a stay of two weeks. But little dredging has been done, so that few accessions of marine life have been made. At Rum Cay, Conception Island, Cat Island, and Great Exuma Island, the naturalists of the expedition obtained many valuable specimens of fish, lizards, birds' nests, eggs, cave relics, pottery, and about 500 bird-skins. These islands are very small and thinly populated. Vegetation is scarce, and the islands themselves are formed almost entirely of rock. Cocoa-nut trees and bananas are abundant, but oranges and apples rather scarce. The *Albatross* is now at Key West, and will spend some time dredging in the Gulf of Mexico and vicinity.

GENERAL HAZEN said recently, in his testimony before a U.S. Congressional Committee, that foreign signal stations were a necessity, and the establishment of a station in the West Indies had fully demonstrated this fact. It is quite probable that Congress will authorise the establishment of stations at important foreign points.

AN interesting discussion is just now being carried on between Scandinavian and German anthropologists as to priority in the theory of three great prehistoric periods—the ages of Stone, Bronze, and Iron. Dr. Sophus Müller, for the former, claims that the theory was first enunciated in 1837 by the Danish Thomsen, and that it was ridiculed for forty years by the Germans. To this Prof. Virchow, in the last *Zeitschrift für Ethnologie*, replies that Dr. Müller confounds two different things. The priority of the Stone Age to the others was never disputed in Germany; it certainly was denied that any epoch deserved especially the title of the Bronze Age, and he thinks that this was due to the propensity of the Scandinavians to exaggerate the extent of this epoch. But he contends that two Germans, Lish and Danneil, discovered the three ages simultaneously with Thomsen. In support of this he quotes a memoir by the former, published in 1837, but in large part printed in 1836, before Thomsen's work appeared, and when it was wholly unknown to him, expounding a similar theory. In 1835 Lish had actually arranged prehistoric objects in the Museum in Mecklenburg according to the three ages. Prof. Virchow therefore proposes that in future Danneil (whose share in the discovery does not appear so pronounced), Lish, and Thomsen should be regarded as the earliest propounders of the theory of the three prehistoric ages.

ON March 28, at about 9 p.m., a magnificent meteor was observed in several places between Trondhjem and Molde, on the north-west coast of Norway. An observer at the former town states that his attention was first attracted to the phenomenon by the street in which he was walking becoming suddenly brilliantly illuminated, and on looking up he saw a bright meteor, with a somewhat faint trail, going in a direction S.S.W. to N.N.W. The light from the body itself was an intensely bluish-white, and that of the trail grayish, with a red tint at the end. During its passage the meteor passed behind some light clouds, and was still visible through them, but not the trail. The meteor disappeared from view behind mountains, but a brightness could still be observed in that direction for some time afterwards. Another observer at Christiansund (about 130 kilometres south-east of Trondhjem in a straight line) states that he saw the meteor at that place at 8.45 p.m., going in a direction S.E. to N.W. It was about 40 centimetres in diameter, with a purple-coloured trail of about $1\frac{1}{2}$ metre in length, and its passage was accompanied by a whizzing sound like that of a flight of birds. The meteor illuminated the whole town brightly for some seconds, and burst with a report like that of a big gun. The light was so intense that even people in well-lighted rooms were attracted by the sudden brightness without. At Molde (about 60 kilometres further south) the meteor was also seen, and its bursting was so loud that the Romsdal Mountains returned a thundering echo.

IN the twenty-ninth issue of the Medical Reports of the Chinese Customs, published half-yearly, besides the reports of the medical officers at the various Treaty ports, which are probably of much professional and local interest, there are two special papers. In one of these the character and uses of the so-called "black-lime" of China are noted by Dr. Peek of Tientsin. This substance is generally stated (Dr. Williams even falls into the error) to be a kind of bitumen; it really is amorphous graphite, and it is used when mixed with lime to make a very hard and durable plaster, and it is also employed in dyeing cloth. The second special paper is Dr. Macgowan's on the movement cure in China, which has been already noticed in these columns.

THE Norwegian Meteorological Office is making an appeal to Norwegian sea-captains with reference to the total eclipse on August 29 next, viz. that any one who on that day happens to be in the locality where the eclipse is total shall make observations of the barometer and thermometer every quarter of an hour from 10 a.m. to 4 p.m. (Greenwich time), with a view to ascertain what the effect of the eclipse is on the atmosphere during totality, a point on which our knowledge is very limited. Proper forms for recording the observations, and full details of instructions, are issued gratis by the Office.

AT a recent meeting of the Russian Physical Society, M. B. Sreznewski pointed out some remarkable oscillations of the barometer during the series of atmospheric storms which had passed over Western Europe and Russia from December 12 to 17 last; namely, the sudden appearance on December 12 in Western Europe of a considerable barometric minimum in a region of very equally spread high atmospheric pressure; secondly, the very low range of the barometer at Nicholaistadt in Finland, as low as 717·6 mm.; and thirdly, the remarkable occurrence of a barometric minimum in Western Russia, which brings the author to conclusions similar to those which served M. Brownoff as a basis for his recently published theory of the movement of cyclones.

IN the month of January shocks of earthquake were felt in several parts of Sweden and Norway. The shock which we reported as having been felt in several parts of Central Norway on January 2 was also felt in several parts of Central Sweden. On January 21, at 9.55 p.m., another shock was felt in and around the town of Hernösand, on the Baltic, going in a direction east to west, and shaking houses and fixtures. On the following morning, at about 5 o'clock, another but fainter shock was felt in the same district. In one place two shocks were felt in quick succession.

A REPORT has been received from Tschembar, in Siberia, giving an account of some remarkable phenomena observed at that place on the night of January 3–4 last. At about 1 a.m. a meteor was suddenly seen rushing across the town, being accompanied by sudden gusts of wind, and bursting with a terrific report near the high-road outside the town, and killing a horse before a cart. The peasant who was driving it was so frightened that he was unable to give any details of the occurrence, believing that it was a "fire-dragon" which had slain his horse. Ten minutes later a loud report as of an explosion was heard, on which the commander of the garrison in the town ordered a patrol to proceed at once to the gunpowder magazine, as he believed it had been blown up. This official had hardly issued the order when a second and more terrific report was heard, accompanied by a violent vibration of the earth, which lasted half a minute. During the shock several houses fell in, and the thick ice on an adjacent lake was broken, the blocks being piled one upon the other. A shock and a similar report were observed at the same time at a town twenty versts distant.

ARRANGEMENTS are being made by the Canadian Commissioners at the forthcoming Colonial and Indian Exhibition to hatch and rear large numbers of Salmonidæ and other fish indigenous to the waters of Canada. Consignments of trout and whitefish ova have already arrived at the Exhibition, and are rapidly becoming incubated.

THE *Journal* of the Asiatic Society of Bengal, vol. liv. part ii. No. 3 (December 1885) contains two valuable papers on Indian entomology. Mr. E. T. Atkinson enumerates fifty-one species of Fulgoridæ (including the Indian lanthorn flies), of which several are indicated as new, and there are copious local (and other) notes on already known forms. Prof. A. Forel, who has paid so much attention to ants in general, enumerates twenty-six Indian species contained in the collection of the Calcutta Museum, with one or two new forms. The only other paper in the part is of a thoroughly practical nature, viz. by Mr. A. Pedlar "On the Cause of the Corrosion of Indian Tea Chests." The author sums up by stating that tea if properly cured has no power to corrode lead, but the corrosion is usually due primarily to acetic acid derived from the unseasoned wood of which the chests are too often made.

DR. MEYER has recently issued an "Album of Philippine Types" (Dresden, 1885), containing thirty-two photographic plates, with altogether about 250 figures of natives of Luzon and Mindanao, the two largest islands in the Archipelago. Some of these were originally taken by Dr. Meyer himself in the year 1872, when he spent some time in the Philippines; for the others he is indebted to Herr C. Heinszen, of Hamburg, Dr. W. Joest, of Cologne, and Dr. A. Schadenberg, of Glogau. Two plates with nine figures are devoted to the little-known Bagobos tribe of South Mindanao; all the rest to the motley populations of Luzon. Here are figured a large number of Negritos (Aetas) and half-caste Malayo-Negritos; Tinguianes, and Igorrotes from the northern and western districts; Ibilaos; Ilongotes from the province of Nueva Vizcaya, and Tagalas of every variety (pure, and half-caste Spanish, Chinese, and Negrito Tagalas) from Manilla and other districts. The accompanying letterpress gives a brief description of the several figures, the reader being referred for fuller information to Prof. F. Blumentritt's valuable treatise on the ethnography of the Philippines, which appeared in *Petermann's Mittheilungen*, Ergänzungsheft 67, 1882.

THE library of the Conservatoire des Arts et Métiers is to be lighted by electricity. It is the first Parisian library which will enjoy this advantage. The inauguration will take place next week, on the occasion of the meeting of the several scientific Congresses, which generally assemble in Paris during the week following Easter.

AT the January meeting of the Russian Chemical Society, Prof. Mendeléeff communicated some results of his investigation into the thermic effects of dilution of sulphuric acid with water. The maximum evolution of heat and the maximum contraction of 100 parts of the solution both correspond to the solution containing from 65 to 75 per cent. of H_2SO_4, which is very near to the hydrate $H_6SO_6 = S(HO)_6$. Together with some other observations this leads the author to the conclusion that there exist at least five more or less constant hydrates of sulphuric acid, as H_2SO_4, H_4SO_5, H_6SO_6, and two more containing a large amount of water, as $H_2SO_4 + 100H_2O$.

CONSIGNMENTS of grayling ova have been received by the National Fish Culture Association and the Buckland Museum. Considering the present period of the year, the fry are unusually late in becoming incubated, but this may be accounted for by the fact that, the past winter being very severe, it has greatly retarded the development of fish life. The ova are fully-eyed, however, and in some instances a few newly-born fish are issuing therefrom.

THE additions to the Zoological Society's Gardens during the past week include a Pudu Deer (*Pudua humilis*), five Chilian Sea-Eagles (*Geranoaetus melanoleucus*), two Siskins (*Chrysomitris barbata*), a Diuca Finch (*Diuca grisea*), two Auriculated Doves (*Zenaida auriculata*) from Chili, a King Vulture (*Gypagus papa*) from Tropical America, five Capoeira Partridges (*Odontophorus dentatus*) from Brazil, two Barn Owls (*Strix flammea*) from America, an Antarctic Skua (*Stercorarius antarcticus*) from the Antarctic Sea, presented by Mr. Harry Berkeley James, F.Z.S.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*), a Barnard's Broadtail (*Platycercus barnardi*) from Australia, presented by Lord Braybrooke, F.Z.S.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. W. Woods; six Field Frogs (*Rana arvalis*) from Breslau, presented by Mr. G. A. Boulenger, F.Z.S.; four Californian Quails

(*Coturnix californica*) from California, a Scarlet Ibis (*Eudocimus ruber*) from Para, deposited; a Roan Kangaroo (*Macropus erube cens*) from South Australia, an Eroded Cinixys (*Cinixys erosa*) from West Africa, a Merrem's Snake (*Liophis merremi*) from South America, purchased; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

RELATION OF ASTEROID ORBITS TO THAT OF JUPITER.—Prof. H. A. Newton, in the *American Journal of Science*, April 1886, points out that the orbits of the asteroids should have a relation to that of Jupiter. For supposing the orbits of the asteroids to be distributed in any manner whatever, provided only that they make small angles with the plane of Jupiter's orbit, the action of Jupiter would give to each orbit a motion of its node which would differ for the different orbits, and eventually the orbits would come to be distributed somewhat symmetrically about the orbit of Jupiter. And as a matter of fact, the centre of gravity of the poles of the 251 known asteroid orbits, computed as for points of equal weight, lies only 30′ from the pole of Jupiter's orbit; so that the plane of Jupiter's orbit lies nearer to the mean plane of all the asteroid orbits than any single asteroid orbit does, the nearest orbits being those of Medusa and Euterpe, inclined to it 46′ and 49′ respectively.

In the same periodical Dr. H. Geelmuyden, of Christiania, remarks, relative to Prof. Searle's deduction that the plane of the zodiacal light has some relation to the asteroid orbits (NATURE, February 11, p. 350), that "the most northerly point of Jupiter's orbit has the heliocentric longitude 188°, or with 60° east elongation 178°; and for matter in the same plane, but nearer the sun, the approximation to coincidence with 160° is still greater."

THE PROPOSED CHANGE IN THE ASTRONOMICAL DAY.—M. Raoul Gautier has recently published in the *Archives des Sciences Physiques et Naturelles* of Geneva an account of the proceedings of the International Meridian Conference held at Washington in October 1884. Remarking that the resolutions passed at Washington are similar in many respects to those of the Roman Conference of the preceding year, M. Gautier goes on to point out how they differ in the important particular of the manner of reckoning universal time, and that on this account a large number of astronomers have expressed their reluctance to conform to these recommendations, more especially to the sixth resolution (which proposed that the astronomical and nautical days should be arranged everywhere to begin at mean midnight of Greenwich), the adoption of which would involve considerable changes in the astronomical and nautical ephemerides, which are used by all observers and navigators. Astronomers, M. Gautier states, as well as sailors, begin the day at noon; the former to avoid changing the date in the middle of the night during a series of observations, the latter because they find it convenient to commence the day at the moment when they observe the sun on the meridian. Why then, he asks with some force, oblige them to modify their habits, now of long standing, considering that the fourth resolution passed at the Washington Conference expressly stipulates that the universal day ought not to interfere with the use of local or other standard time where the latter appears desirable?

THE PLEIADES AS SEEN AND AS PHOTOGRAPHED.—MM. Henry have recently compared their beautiful photographic map of the Pleiades with the map so carefully laid down by M. Wolf in 1873–75, and published in vol. xiv. of the *Mémoires de l'Observatoire de Paris*, and find that the photograph possesses the following advantages over the map made by direct eye-observation. The photograph shows faint objects which are lost to the eye through their proximity to bright stars; thus the Maia nebula, and another near Electra, have been made evident, as well as details recognised hitherto only by Mr. Common in the Merope nebula. A number of faint companions have also been detected close to several of the brightest stars of the group, and in several cases where M. Wolf had detected a faint companion to a bright star, the photograph has shown that the magnitude of the former was under-estimated. Many more stars are seen on the photograph than are given in M. Wolf's map, the former showing 1421 stars, the latter 625; the aperture of the instrument employed being about the same in both cases. A yet more striking instance of the superior sensitiveness of the plate is seen in the fact that M. Rayet, in his revision of M. Wolf's map in the pure air of Bordeaux, and with a much more powerful instrument, added only 151 stars in a region where the photograph gave 338. All the stars observed by M. Wolf are seen in the photograph but ten, and these cannot be found in the sky.

The Brothers Henry, whilst laying stress on these facts as showing how indispensable a weapon photography has now become to the astronomer, disclaim the idea of criticising M. Wolf's great work, and completely assent to his opinion, expressed in the *Comptes rendus*, vol. cii., No. 9, that the eye of the observer must continue to work at the same time as the sensitive plate; the latter can never supersede the former.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 APRIL 25—MAY 1

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 25

Sun rises, 4h. 45m.; souths, 11h. 57m. 51·4s.; sets, 19h. 10m.; decl. on meridian, 13° 15′ N.: Sidereal Time at Sunset, 9h. 25m.

Moon (at Last Quarter April 26) rises, 0h. 57m.; souths, 5h. 28m.; sets, 10h. 2m.; decl. on meridian, 17° 22′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 16	10 37	16 58	3 29 N.
Venus	3 25	9 6	14 47	4 21 S.
Mars	13 19	20 21	3 23*	11 16 N.
Jupiter	15 20	21 37	3 54*	2 32 N.
Saturn	7 51	16 3	0 15*	22 51 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

April	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
28	*e*¹ Aquarii	6	3 38	4 42	42 288
29	78 Aquarii	6	2 49	3 8	139 175

April	h.	
28	6	Mercury at greatest distance from the Sun.
29	17	Venus at greatest elongation from the Sun, 46° west.
30	5	Venus in conjunction with and 0° 19′ north of the Moon.

Positions of the Comet Fabry

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 25	1 45 25	31 18 N.	9·420	315
27	2 29 43	24 51	9·355	400
29	3 20 22	15 22	9·309	465

Positions of the Comet Barnard

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 25	1 39 50	39 53 N.	0·047	67
27	1 38 41	40 19	0·023	80
29	1 38 8	40 31	9·997	94

The comet positions are for Berlin midnight.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
R Leporis	4 54·4	14 59 S.	Apr. 26,	0 0	*m*
δ Libræ	14 54·9	8 4 S.	,, 25,	3 26	*m*
U Coronæ	15 13·6	32 4 N.	,, 30,	1 53	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 25,	1 31	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Apr. 28,	2 20	*m*
			May 1,	0 0	*M*
W Sagittarii	17 57·8	29 35 S.	Apr. 25,	21 40	*m*
			,, 29,	2 25	*M*
U Sagittarii	18 25·2	19 12 S.	,, 26,	2 30	*m*
			,, 29,	2 20	*M*
β Lyræ	18 45·9	33 14 N.	,, 29,	21 35	*M*
η Aquilæ	19 46·7	0 7 N.	,, 29,	21 40	*M*
R Vulpeculæ	20 59·3	23 22 N.	,, 25,		*m*
δ Cephei	22 24·9	57 50 N.	May 1,	0 0	*M*

M signifies maximum; *m* minimum.

Meteor Showers

The principal shower of this week is that of the *Aquarids*, radiant R.A. 326°, Decl. 2° S. It is a strong shower, visible just before daybreak, from April 29 to May 2.

GEOGRAPHICAL NOTES

THE Geographical Society of Paris held last Friday its first general annual meeting. M. de Lesseps was in the chair, and delivered an address on the Panama Isthmus and Canal. Amongst the gold medallists are MM. Capello and Ivens, the Pandit Krishna, and Alfred Marche.

M. PELLET, a French explorer belonging to the cavalry, was murdered by an unfaithful guide on his way to Timbuctu, before reaching Insalah, the capital of Tuat.

THE Portuguese Legislature has, at the initiative of the Geographical Society of Lisbon, passed an act relating to MM. Capello and Ivens, of which the following are the main provisions:—(1) They are to receive a pension of 600,000 *reis* (135*l.*) per annum each, in addition to a similar pension granted to them after their first journey; (2) exemption from all taxes; (3) the Treasury is to bear the expense of printing an edition of the account of their last African journey, of which 5000 copies will be given to them, and the copyright will be their property; (4) confirmation of the rank conferred on them, and dispensing with the condition of serving the remainder of the term in Africa in consideration of which the rank was granted to them by law. Portugal, it would thus appear, knows how to honour officially, as a nation, her sons who have done honour to her. MM. Capello and Ivens's work is in the National Press at Lisbon, and the first volume is expected to be published in two months.

THE current number (Band v., Heft 1) of the *Mittheilungen* of the German African Society is full of interesting matter. The contents are divided into two parts: (1) the reports of the Society's explorers in the Congo region, and (2) those in the Western Soudan. The first part contains Dr. Büttner's diary of his journey during July, August, and September last year. Leaving Arthington Falls on July 3, he travelled eastward to the Quango, at its junction with the Quilo, which point he reached on the 21st of the same month. He then turned south along the right bank of the Quango for seven days, as far as Muene Putu, where he stayed for a fortnight, again returning northward, and crossing to the left bank near the spot where the Quilo joins it. Leaving this on August 21, he continued down the left bank to Kiballa, whence he turned westward to Stanley Pool. A map compiled by Dr. R. Kiepert accompanies the diary, and also tables of various measurements calculated by Dr. von Danckelman. The reports from the Expedition in the Western Soudan are written by Dr. Flegel (from Bakundi, on the Tarabba) and Dr. Semon.

THE last number of the *Mittheilungen* of the Geographical Society of Vienna, like so many similar publications just now, is mainly devoted to African geography. It contains, with a description, routes, &c., a map of the neighbourhood of Ango-Ango, by Herr Baumann, a member of Dr. Lenz's Austrian Congo Expedition. The topographical material was collected during a stay at Ango-Ango, and was put together in Vienna. Two further letters from Dr. Lenz are also published: the first describes the journey from Ngombe to Stanley Pool, and the second the journey to the Equator Station on the Upper Congo. It is satisfactory to learn that the Expedition reached this point in excellent health, and that the Free State officials gave it every assistance. The only other paper in the number is the conclusion of Dr. Diener's contribution to the geography of Central Syria. At the end he confesses that it is at present impossible to say whether the physical features of a great part of this region have altered since the days of the Romans. There are facts, historical, climatic, and geographical, which tend in favour of both sides, and the problem is one for solution in the future.

ACCORDING to a recent communication of M. Venukoff to the Geographical Society of Paris (to which we have already referred), the results of a survey of the basin of the Neva, executed in 1884-85, show that hitherto the levels generally accepted by geographers here have been totally incorrect. The following is a comparison of the levels now ascertained with those given by M. Reclus in his "Géographie Universelle" for Lakes Ladoga, Onega, and Ilmen:—

	New Survey	M. Reclus
Ladoga ...	5·01 metres ...	18 metres
Onega ...	34·97 ,, ...	72 ,,
Ilmen ...	17·97 ,, ...	82 ,,

These figures, and others which might be quoted, show that the region watered by the Neva and its tributaries is much lower than was generally supposed. The new figures refer to the normal zero of Cronstadt, which is itself 0·66 m. above the level of the Baltic at Revel. The absolute heights of the lakes is thus slightly increased, but still the differences between the old and the new figures are very great. As the results of the new survey appear unquestionable, the former hypsometric details respecting the basin of the Neva must be dismissed as wholly incorrect.

THE French Topographical Society proposes that an International Exhibition of Topography should take place in the Palais de l'Industrie next year, under the patronage and with the assistance of the Government. The Committee of Organisation which has been appointed has addressed a circular to French topographers, geologists, geographers, and explorers, asking for their co-operation. The Society, the circular says, has for its aim the popularisation of the science of topography, especially by means of gratuitous lectures, and it is anticipated that an exhibition will give a spur to this work.

SOME RESULTS OF OBSERVATIONS WITH KITE-WIRE SUSPENDED ANEMOMETERS UP TO 1300 *FEET ABOVE THE GROUND IN* 1883-85

SINCE I had the honour of reading a paper on the first series of observations taken in 1883-84 before the Association in Montreal last year, I have made twenty-five fresh observations at heights above the ground varying from 300 to about 1300 feet, or double the greatest height before attained. I had hoped in have been able to make a greater number and variety of observations, but a pressure of private and other work has stood to the way.

Since, however, in ten of the new observations the upper anemometer was suspended at a height of over 1000 feet above the ground, or 1500 feet above the sea, I trust the results may be thought sufficiently novel and valuable to merit the brief discussion to which I have subjected them.

In dealing with the observations I have included fifteen of those made in 1883-84, and have thus been able to utilise forty observations in all. As the observations were intentionally made as nearly as possible at certain desired heights, so as to afford a regular progression upwards in the scale of height, I have been able to arrange forty-two pairs of observations at two different levels in six groups.

In order to present the results in a form in which they can be readily compared, as well as to exhibit the law of change of the velocity with the height, I have computed for each observation the value of the corresponding exponent in the empirical formula $\frac{V}{v} = \left(\frac{H}{h}\right)^x$, where V, v, H, h, are the velocities and heights of the upper and lower instruments respectively. The several groups, together with their corresponding heights, mean velocities, and exponents, are given in the following table:—

TABLE I.

Group	No. of observations	Mean height of upper instrument above ground, in feet	Mean height of lower instrument above ground, in feet	Mean height of both	Mean velocity at both heights in feet per minute	Mean upper and lower velocities: Upper	Lower	Mean value of x
* 1	7	250	102	176	1395	1617	1174	0·372
2	3	322	128	225	1955	2232	1679	0·307
* 3	8	407	179	293	1545	1705	1385	0·275
4	5	549	252	400	1940	2107	1773	0·237
5	9	795	481	638	2074	2192	1957	0·250
6	10	1095	767	931	2166	2236	2096	0·194

The general and obvious conclusion to be drawn from this table, as well as from the individual observations (in which a reverse case has never occurred), is that the velocity of the wind

* These two groups comprise observations made in 1883-84 only. The other groups those made in 1884-85 only.

TABLE II.—*Exponents in Formula* $\frac{V}{v} = \left(\frac{H}{h}\right)^x$ *arranged for Different Mean Velocities in all 6 Groups. Groups and Values of x with the Corresponding Mean Resultant Directions D**

Range of mean velocities in feet per minute	1	*D*	2	*D*	3	*D*	4	*D*	5	*D*	6	*D*
700 to 1100	·422 (1)	N. 85 W.	—	—	·343 (2)	N. 39 W.	—	—	·576 (1)	N. 43 W.	·279 (1)	N. 43 W.
1100 to 1500	·345 (5)	S. 83 W.	—	—	·376 (2)	S. 14 W.	·290 (1)	N. 59 E.	·235 (1)	S. 26 W.	—	—
1500 to 1900	·440 (2)	S. 22 W.	·286 (1)	S. 63 E.	·156 (2)	N. 61 W.	·290 (2)	S. 22 W.	·214 (1)	N. 39 W.	·290 (1)	N. 71 W.
1900 to 2300	—	—	·317 (2)	N. 19 W.	·225 (2)	S. 21 W.	—	—	·212 (2)	N. 24 W.	·196 (5)	S. 80 W.
2300 to 2700	—	—	—	—	—	—	·158 (2)	N. 53 E.	·237 (3)	N. 16 E.	·239 (1)	N. 40 E.
2700 to 3100	—	—	—	—	—	—	—	—	·091 (1)	N. 57 E.	·077 (2)	N. 57 E.
Mean range of exponent for 400 feet of velocity. + if it varies directly, − „ inversely, with velocity	+ ·009		+ ·031		− ·039		− ·033		− ·097		− ·040	

TABLE III.—*Exponents in Formula* $\frac{V}{v} = \left(\frac{H}{h}\right)^x$ *arranged for the Different Hours of the Day during which the Instruments were suspended, together with the Mean Velocities (V′) and Directions (D) of the Wind* †

Hours	Group 1 *x*	*D*	*V′*	Group 2 *x*	*D*	*V′*	Group 3 *x*	*D*	*V′*	Group 4 *x*	*D*	*V′*	Group 5 *x*	*D*	*V′*	Group 6 *x*	*D*	*V′*
11 to 12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	·058 (1)	N. 57 E.	2703
12 to 1	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	—	—	—	·174 (2)	N. 7 W.	2286
1 to 2	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	—	—	—	·154 (3)	N. 31 E.	2286
2 to 3	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	·235 (1)	S. 26 W.	1368	·087 (2)	N. 60 E.	2494
3 to 4	—	—	—	·307 (3)	N. 45 E.	1956	·257 (5)	N. 75 W.	1580	·119 (1)	N. 39 E.	2378	·163 (4)	N. 61 E.	2183	·116 (4)	N. 41 W.	2479
4 to 5	·386 (4)	S.	1521	·332 (2)	S. 17 W.	1889	·263 (6)	S. 89 W.	1546	·183 (2)	N. 36 W.	1945	·240 (8)	N. 22 W.	1997	·185 (7)	N. 70 W.	2129
5 to 6	·335 (5)	S. 34 W.	1348	·286 (1)	S. 63 E.	1609	·342 (4)	S. 18 E.	1460	·237 (5)	N. 78 E.	1940	·252 (8)	N. 13 W.	2162	·192 (8)	N. 41 W.	2188
6 to 7	·315 (3)	S. 45 W.	1284	·286 (1)	S. 63 E.	1609	·414 (2)	N. 82 E.	1203	·237 (5)	N. 78 E.	1940	·251 (7)	N. 13 E.	2194	·215 (6)	N. 48 W.	2099
7 to 8	—	—	—	—	—	—	·458 (1)	S. 23 E.	1402	·204 (2)	N. 49 E.	1884	·328 (1)	N. 49 E.	2691	—	—	—
Ranges of exponents and velocities	− ·071		− 237	− ·046		− 280	+ ·295		− 233	+ ·118		− 438	+ ·165		+ 508	+ ·128		− 395

+ if increasing, − if decreasing, towards evening; ══ signifies maximum, —— minimum.

* The resultant wind directions when calculated from more than two observations have been derived by means of Lambert's formula.

† The resultant wind directions are calculated by Lambert's formula.

always increases from the surface of the ground up to 1800 feet above sea-level, and that the ratio of the increase steadily diminishes up to that height. The only exception to the steady decrease in the value of x occurs in Group 5, and this is evidently due to the inclusion in that group of an abnormally large value of x (0·576), corresponding to an equally abnormally small velocity of 789 feet per minute, which is little more than a third of the mean velocity of the stratum corresponding to that group. The mean velocities of each group are also seen to increase with some degree of regularity with the height, but this is, of course, partly accidental. In estimating the value of the exponent x for strata of the atmosphere at different heights above sea-level, it must be remembered that the place of observation is 500 feet above sea-level, and therefore that at a certain height above the ground the motion of the air in all probability approximates to what it would have at its real height above the sea. Where this state of things *actually* occurs, we have no ready means of determining, but at a height of 1000 feet above the ground we may assume that the influence of the subjacent tableland is almost obliterated, and the motion of the air *approximates* to what it would have at its real sea-level height. On this assumption, if we add the full 500 feet to each height in Group 6, we get the following value for the exponent :—

	Upper sea-level height	Lower sea-level height	Value of x
Group 6	1595	1267	0·28

If more reasonably we add 400 feet only, we get $x = 0·26$, or almost identically the same value as 0·25, which I found agree best on the average with Dr. Vettin's cloud observations at Berlin, ranging from 1600 to 23,000 feet above sea-level (NATURE, January 11, 1883). I think, therefore, that the results of the present series of observations may be taken to add strong confirmation to the general agreement of the empirical formula $\frac{V}{v} = \left(\frac{H}{h}\right)^{0·25}$, with the average motion of the air at heights over 1600 above sea-level.

One great advantage which results from the representation of the observations in the form of exponents is that we are thus enabled to compare observations differing from one another, both as to height and velocity, in a manner which would otherwise be almost impossible.

There are four principal variables which have been observed, and which are likely to affect the value of these exponents, viz. (1) the mean velocity at the upper and lower elevations; (2) the direction of the wind; (3) the time of day; and (4) the month of the year. I have, so to speak, differentiated the exponents with respect to each of these variables in turn, and have in each case placed the corresponding values of the other variables alongside, in order to see how much of the resulting variation of the exponent is independent, or dependent on accidental collocations of the other variables. The results I find most curiously involved, owing to apparently accidental groupings of some of the variables.

One or two variations can, however, be shown to arise from the influence of one factor alone, after that due to the co-existence of others is allowed for. One of these is that due to the change of mean velocity, and the other is the diurnal change with the hour of the day. These are shown in the accompanying Tables II. and III. respectively.

In Table II. the exponent is found, on the whole, to increase with an increase in the velocity in the two lowest groups (1 and 2), and to decrease in the four upper groups, the maxima in each of these groups occurring at the lower velocities, and the minima at the highest ones.

This latter result is what might have been expected *a priori*, and though the first two groups would appear at first sight to present an anomaly, it must be remembered that in these groups the lower instrument is hardly above the influence of surrounding trees, so that in high winds, while the upper instrument might be feeling the full force of the wind, the lower one might be unduly sheltered from it by adjacent trees or buildings.

In Table III. the diurnal variation in the value of the exponents, reaching its minimum from 2 to 3 or 3 to 4, and its maximum between 6 and 8 (as far as the observations go), is most clearly and regularly shown in each of the four upper groups, and as these last are well beyond the influence of local obstructions, I regard the uniformity with which they exhibit this variation as a strong proof in favour of its physical existence independently of any similar variation caused by the parallel march of other factors. Even if part of the variation in groups 3, 4, and 6 is due to the equally regular decrease in the mean velocity from midday to evening, it can be shown from Table II. that this only accounts for a portion of the observed variation.

Thus, taking the ranges of the exponents in Table III., and adding to or subtracting from them the proportional ranges of the exponents for the corresponding opposite range of velocity (deduced from the mean range of the exponents for 400 feet range of velocity in Table II.), we get the following results :—

	Groups	1	2	3	4	5	6
Ranges of exponents from diurnal minimum to diurnal maximum; + increasing towards evening; – decreasing towards evening.		–·065	–·025	+·273	+·083	+·286	+·088

that is to say, for Group 5 the variation is increased, and for the rest not materially diminished.

The opposite variation in the two lowest groups (1 and 2) may be capable of an explanation somewhat analogous to the similar anomaly presented by these two groups in Table II., but in any case it cannot be said either to sensibly corroborate or invalidate the physical existence of the variation so statistically marked in all the four upper groups.

This diurnal change in the value of the ratio of the velocity of the upper to the lower strata which is here shown to occur for the afternoon hours, is confirmed by various other casual observations, and is in complete accord with the results afforded by anemometrical observations on Ben Nevis and other lofty mountain observatories, as well as with Dr. Köppen's theory of the diurnal period in the surface-wind alluded to in my former paper.

Since at stations near sea-level the diurnal wind-velocity reaches its maximum at midday and its minimum at midnight, while at lofty stations about 4000 feet above sea-level the critical epochs are reversed, it is evident that somewhere between these levels a neutral plane exists where the diurnal variation is *nil*. The ratio of the upper velocity to the lower for a given difference of height would, however, continue to vary diurnally all the way up (unless some unknown law intervene), reaching its minimum value about midday and its maximum about midnight.

Indications of other laws have been noticed in the value of the exponents, such as a maximum for west winds and a minimum for east winds in five out of six of the groups, and also a maximum in the autumn, minimum in the winter, and maximum again in the summer in all the groups, but the observations are too few and the factors too involved to establish these with any certainty. I trust on a future occasion to be able to go into these questions more in detail, and also to supply the morning half of the diurnal variation, which I consider to be the most certain and valuable result I have as yet obtained in addition to the law of the general progressive decrease in the value of the exponent up to 1800 feet above sea-level in the *free* atmosphere.

E. DOUGLAS ARCHIBALD

BASIC CINDER[1]

THE interest of this report centres principally around the question of the manurial value of undissolved phosphates present in basic steel slag or cinder. The basic cinder is the effete and broken up basic lining of the converters used in the Thomas and Gilchrist process for dephosphorising iron, and is made in very large quantities as a by-product of steel manufacture. It contains from 16 to 19 per cent. of phosphoric acid in union with lime and other bases in combinations insoluble in water.

At the request of the North-Eastern Steel Company Prof. Wrightson and Dr. Munro undertook field experiments in order to test the manurial value of this substance. These experiments were carried out last summer on the College farm at Downton, and at East Howle, Ferry Hill, county of Durham, upon dissimilar soils, and under different climatic conditions. The results as given in the very concise report before us are remarkable, and certainly must be highly satisfactory to those who are interested in the future of basic cinder. The value of this substance as a fertiliser for swedes and turnips, as well as for grass, is placed beyond reasonable doubt by a most remarkable unanimity of results obtained at both experimental stations. Each series

[1] "Report on Experiments made to test the Manurial Value of Basic Cinder from the North-Eastern Steel Works." By Prof Wrightson and Dr. Munro, of the College of Agriculture, Downton, Salisbury. Middlesbrough: *Daily Exchange* Offices, 1886.

was composed of thirty-five plots of one chain square, or of one-tenth of an acre each, and comprised forty drills or rows of plants. The plots were arranged to form five rows of seven plots each, and a rectangle of three and a half acres. They were so disposed within this area that every manured plot was adjacent to an unmanured plot, with the object of obtaining repeated confirmations of any differences which might be indicated in favour of the dressings. Every trial was made in duplicate in both series, and the results are graphically shown by tinted plans, on which the number of the plot, the manurial dressing used, and the number and weight of roots grown are printed.

Not only do these experiments prove ground basic cinder to be a valuable fertiliser, but they assign it a higher position than ground coprolite, and place it only slightly below "superphosphate" in value. This remarkable result is, we find, supported by statements resting on the authority of Dr. Biedermann *Centralblatt* (vol. xiv. part 2), in which the phosphoric acid in basic cinder is asserted to be more readily appropriated by growing plants than is the phosphoric acid contained in coprolites.

The subject is full of interest as bearing upon the positive profits of steel manufacture, and also upon the manufacture of superphosphate and upon agricultural practice. It has attracted the attention of M. Grandeau, of the Faculty of Science of the French University, who contributed a review of the pamphlet before us occupying over three columns of *Le Temps* newspaper. In the course of his remarks he says:—"Les résultats obtenus en Angleterre confirment pleinement, on le voit, ceux que les agronomes allemands ont publiés et que j'ai précédemment analysés. Les scories de déphosphoration sont appelées à jouer un rôle considérable dans la fumure du sol. Des négociants ont déjà traité avec quelques-unes des importantes usines de l'Est (Alsace-Lorraine notamment) pour l'achat de toute leur production de scories."

The experiments conducted at Downton and Ferry Hill were not only instituted to ascertain the positive value of ground basic cinder in comparison with unmanured plots. In them the ground cinder was compared with ground coprolite, with ordinary superphosphate, with a rich superphosphate, with a superphosphate made direct from the basic slag, and with a superphosphate to which green vitriol was added. The subject is likely to arouse a very considerable amount of attention.

AN IMPROVED FORM OF TEMPERATURE REGULATOR

IN 1882, at the request of the Board of Trade, the Royal Society appointed a Committee, consisting of Sir G. Airy, Col. Clark, and Prof. Stokes, to advise on the question of improving the existing means of the comparison of standards of length at the Standard Office. In their report the Committee suggested improvements in the arrangement for securing greater uniformity and steadiness of temperature in the bars under comparison. As a first step in this direction, the Cambridge Scientific Instrument Company were requested to investigate the subject of temperature regulators, and to consider the general design of a comparing apparatus. They proposed that the standards, some hours before they were observed, should be placed in metal cases and immersed in a bath containing water; and that they should not be disturbed during the process of observation. If the uniformity of temperature of the water could be ensured, it would secure the equality of temperature of the standards and remove one of the greatest difficulties in the construction of a satisfactory comparing apparatus.

After some preliminary trials a regulator was constructed similar to that used at the Bureau International des Poids et Mesures at Sèvres.[1] Its action depends on the variation of pressure of a saturated vapour, caused by a change of temperature. The pressure on the volatile liquid and vapour is due to the atmosphere, as well as to a column of mercury; consequently the regulated temperature will vary with any change in the atmospheric pressure. In the following experiments the corresponding change of temperature for one inch alteration of the barometer was about $0^{\circ}\cdot 37$ C. The accuracy of the regulator therefore depends on the constancy of the atmospheric pressure, and to overcome this serious disadvantage an arrangement was devised for maintaining a constant pressure on the volatile liquid.

[1] See "Travaux et Mémoires du Bureau International des Poids et Mesures," tome i. p. C. 10.

An iron bath, D (Fig. 1), containing water, was placed in a wooden box. The intermediate space was filled with sawdust; this was done to minimise the unequal cooling due to the varying temperature of the room. The two ends of a U-shaped tube were fixed into the bottom of the iron bath and passed through holes in the side of the wooden box. The water was kept warm by means of two gas-flames placed under a part of this tube. One of the gas-flames was connected to the regulator and the other direct to the gas-main. The object of the second flame was to re-light the regulated gas-jet in case it should have been extinguished by the regulator.

The water in the bath was kept thoroughly stirred by air forced through it by means of bellows. These were placed inside the box in order to keep them warm, and also for the more important reason of avoiding the currents of air which would otherwise be produced at each stroke. The air used for

Fig 1

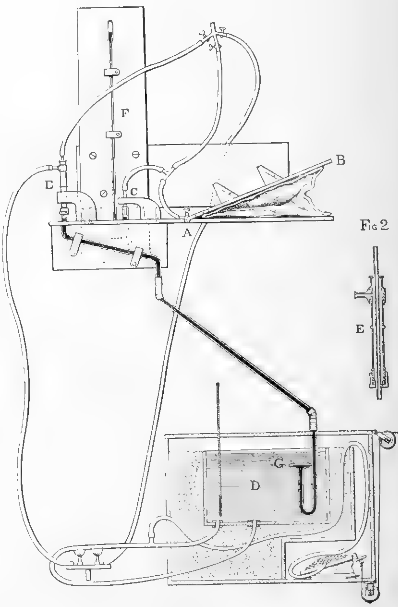


Fig 2

stirring was thus saturated with aqueous vapour, and did not cool the water in the bath by absorbing moisture from it. The nozzle of the bellows was connected to the U-shaped tube by a branch inserted just above the point where the gas-flame was applied. The air thus pumped through the upper part of the U-tube caused a rapid circulation of water through it. This method has the advantage of applying the heat in a manner which does not tend to make the water in one part of the bath perceptibly hotter than the rest.

The volatile liquid in the regulator was a mixture of methyl-chloride and ethyl-chloride, boiling at about $2\frac{1}{2}^{\circ}$ C. under the normal atmospheric pressure. It was contained in a flat bulb, G, blown at the end of a glass tube, and was under a head of mercury. The glass tubes containing the mercury were connected by short lengths of canvas-lined india-rubber tube. A double brass tube was secured to the open end of the regulator, E; this is shown enlarged in

Fig. 2. The gas entered by the inner tube, which passed down to the surface of the mercury, and the outer tube was connected with the gas-burner placed under the U-shaped heating-tube. Thus a rise of mercury in the regulator reduced the supply of gas to the burner. The cross-section of the flat glass bulb at the common surface of the mercury and volatile liquid was large compared with the cross-section at the upper end of the regulator; thus nearly all the increase in height due to expansion of the volatile liquid and vapour takes place at the upper end of the regulator, and the level of the common surface of the mercury and volatile liquid remains nearly constant.

The most interesting part of the apparatus is the arrangement for compensating for the variation of atmospheric pressure. With this object a barometer in the form of a bent tube is fixed at F. To simplify the explanation we will suppose that the atmospheric pressure diminishes by an amount equal to a head of one inch of mercury; this will cause the mercury in the open end of the barometer to rise half an inch. If the regulated gas-flame is to be extinguished when there is a constant pressure on the volatile liquid, then the tube E must be raised one inch; thus it must move in the same direction as and twice the amount of the exposed surface of the mercury in the barometer. To accomplish this the upper part of the regulator was attached to a board turning about a horizontal axis, A. A gas-bag was placed between the projecting end of this board and a fixed board, B. The board turning about A was so weighted as to tend to close the bag. The nozzle of the bag was connected to the gas-main, and a branch pipe led to a small tube, C, passing down the open end of the barometer. This small tube was fixed by a bracket to the movable board half-way between the upper end of the regulator and the pivot A. Now if the mercury rises in the open end of the barometer it closes the tube C, and the gas from the main passes into the bag, forces the boards apart, and raises both the upper end of the regulator and the tube C, until the escape restores the equilibrium. The flexible india-rubber connections in the glass tubes allow the necessary movement to take place. This arrangement is of interest, as the pressure of the gas-supply is the motive-power for automatically moving a piece of mechanism in a required manner.

The apparatus was kept in action for fourteen days without readjustment, but the stirring of the water was discontinued at night. The thermometer was read about ten times a day, and from July 18 to August 1 the extreme readings were 30°·90 C. and 30°·86 C. The greatest change of temperature during any day was 0°·04 C., the least observed change during any day was 0°·01 C., and the longest period during which no change was observable was from 12.30 p.m. on July 20, to 1 p.m. the following day. At night, when the stirring was discontinued, the variation of the temperature was greater, but it settled down to its normal amount shortly after the stirring began. In a properly-constructed comparing-room the change of temperature would have been less. On one occasion the barometer rose rapidly, nearly half an inch in twenty-four hours, and during this time the temperature of the water did not vary perceptibly. If the barometer had not been attached to the regulator, this change of pressure on the volatile liquid would have produced a change of 0°·14 C. in the bath.

The apparatus was roughly made in an experimental form, but the results were highly satisfactory. There were no doubt errors in the readings of the thermometer. Sir William Thomson, in his article on "Heat" in the "Encyclopædia Britannica," describes an error which may be introduced owing to the mercury in the stem of a thermometer remaining at rest whilst slight changes of temperature are occurring, and then moving suddenly into a new position, where it again remains at rest. This phenomenon was observed in the very delicate thermometer used.

The variation of temperature due to the expansion of the mercury in the barometer and regulator was perceptible, and agreed roughly with the amount arrived at by calculation. Very small errors were also probably introduced by the following causes: the sticking of the mercury in the regulator and the barometer; variation of the gas-pressure; imperfections in the mechanism and of the vacuum in the barometer. There can, however, be little doubt that the errors produced by these and other causes could be reduced to an inappreciable amount, and if the apparatus were placed in a room of fairly constant temperature, remarkable results could be obtained.

HORACE DARWIN

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xviii., fasc. ii.—On the analysis of platinum ores, by F. Willm. All former methods of the separation of noble metals, though sufficient for technical purposes, are considered not exact for the scientific determination. Electrolytic method is recommended.—On the thermic effects of the replacement of hydrogen by bromine in the aromatic compounds, by E. Werner.—On cholanic and bileanic acids, by P. Latchinoff. Both having been obtained from cow's bile and formulæ proposed for the former $C_{25}H_{38}O_7 + \frac{1}{4}H_2O$, and for the latter $C_{25}H_{36}O_8 + \frac{1}{4}H_2O$.—Contribution to the theory of the influence of the decomposition of a body due to heat or to mechanical influences, on its magnetism, by P. Bakmetieff.—Thermo-electrical researches, by the same author. The starting-point for these researches being the fact observed by the author, that the thermo-electro generative force in the metal rods, which serve as thermo-elements, undergoes variations under the influence of the contraction or expansion of the rods parallel to those of magnetism in the same metals and from the same causes.

Rendiconti del Reale Istituto Lombardo, February 18.—State of public instruction in Italy, by Prof. A. Amati. In general the results here tabulated of an inquiry into the present state of instruction throughout the peninsula show that the number of unlettered is in direct proportion with that of the criminal classes.—On a phenomenon of intermission in the sense of hearing, by Prof. A. Raggi. It is shown that under certain conditions regularly recurring sounds strike the auditory faculty in rhythmically recurring waves of greater and less intensity. The phenomenon is regarded as the direct result of perception, the reflex act represented by the awakened attention not being produced with a uniform degree of energy continued throughout the duration of the stimulus, the lack of uniformity being itself due to the feeble degree of excitement.—Note on a simple and obvious, but not hitherto noticed deduction from Taylor's formula in infinitesimal analysis, by Gian Antonio Maggi.—Remarks on a normal metamorphosis of the scented violet due to the presence of the larva of *Cecidomyia destructor*, by Dr. S. Calloni.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 25.—"On the Changes produced by Magnetisation in the Length of Iron Wires under Tension." By Shelford Bidwell, M.A., LL.B. Communicated by Prof. F. Guthrie, F.R.S.

In a paper communicated to the Royal Society about a year ago, the author discussed the results of certain experiments made by Joule in relation to the effects of magnetism upon the dimensions of iron and steel bars.

It is well known that the length of an iron rod is in general slightly increased by magnetisation. Joule enunciated the law that the elongation is proportional in a given bar to the square of the magnetic intensity, and that it ceases to increase after the iron is fully saturated. The author's experiments, made with a greater range of magnetising forces and with thinner rods than those used by Joule, showed that if the magnetising current were gradually increased after the so-called saturation point of the iron had been reached, the elongation, instead of remaining at a maximum, was diminished, until, when the current had attained a certain strength, the original length of the rod was unaltered, and if this strength were exceeded, actual *retraction* was produced.

Joule also found that when the experiment was performed upon an iron wire stretched by a weight, the magnetic extension was in all cases diminished, and if the weight were considerable, magnetisation caused retraction instead of elongation. From these facts he appears to have formed the conclusion that, under a certain critical tension (differing for different specimens of iron, but independent of the magnetising force), magnetisation would produce no effect whatever upon the dimensions of the wire. In one of his experiments a certain iron wire loaded with a weight of 408 lbs. was found to be slightly elongated when magnetised; the weight was then increased to 740 lbs., with the result that magnetisation was accompanied by a slight retraction. In both cases the magnetising currents varied over a considerable range, and the smaller ones were without any visible effect. Commenting upon these results, Joule conjectured that "with a tension of about 600 lbs. (which number is roughly the mean of 408 and 740) the effect on the dimensions of the wire would cease altogether in the limits of the electric currents employed in the above experiments."

In reference to this surmise the author in his paper of last year expressed his belief that, if Joule had actually made the experiment, he would have found that the length of the wire was increased by a weak current, that a current of medium strength would have had no effect whatever, and that one of his stronger currents would have caused the wire to retract. He had, in fact, reason to believe that the effect of tension was to diminish the "critical magnetising force" (which produces maximum elongation), so that the retraction which is found to occur in all iron rods when a sufficient magnetising force is employed, is observed with smaller magnetising currents when the rod is stretched than when it is free, but want of suitable apparatus prevented him from submitting this idea to the test of direct experiment.

		Commercial iron wire, diam. 1·2 mm.				Charcoal iron strip, section 3 mm.				Hard wire, diam. 2·6 mm.		Soft wire, diam. 3·25 mm.	
Stretching load ...		3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	14 lbs.	3 lbs.	14 lbs.
Smallest current producing sensible elongation	Amperes	0·043	0·064	0·084	...	0·033	0·020	0·029	0·064	0·12	0·15	0·064	0·033
Current producing maximum elongation	Amperes	0·49	0·39	0·23	...	0·44	0·33	0·27	0·15	0·70	0·58	0·70	0·58
Current by which original length is unaffected ...	Amperes	0·99	0·73	0·47	0·23	1·30	0·99	0·77	0·53	0·99	0·94	1·24	1·09
Maximum elongation in scale divisions	Scale divisions	2	1·5	0·5	...	10	6	4	1	2·5	2·5	6·5	4·5
Retraction with current of 1·6 ampere	Scale divisions	6	9·5	11	11	9	15	18	20	11	11	8	11

The magnetic field at the centre of the coil = current × 92.
One scale division = one five-millionth part of the length of the wire.

He has lately modified the instrument, which was described in his former paper, in such a manner that it can be used for observing the effects of magnetisation upon rods and wires under traction, and the results of a series of experiments made with it are presented in a synoptical form in the above table. Four specimens of iron were used. The first was a wire of commercial iron, 1·2 mm. in diameter, which had been softened by heating in a gas flame; the second was a strip of annealed charcoal iron, 5·5 mm. wide and 0·55 mm. thick, its sectional area being about 3 mm.; the third was a piece of hard unannealed wire, 2·6 mm. in diameter; and the last was a wire of very pure soft iron, 3·25 mm. in diameter, which had been carefully annealed. These were successively fixed in the apparatus, and loaded with weights varying from 3 lbs. to 14 lbs. While under the influence of each load, four observations were made in the case of each wire:—(1) A determination was attempted of the smallest magnetising current which sensibly affected the length of the wire in the direction of elongation or retraction. (2) The current producing *maximum* elongation (if any) and the extent of such maximum elongation were found. (3) A determination was made of the critical current which was without effect upon the original length of the wire, *i.e.* the current of such strength that a weaker one would cause elongation and a stronger one retraction. (4) The retraction produced by a fixed current of 1·6 ampere was measured.

The figures recorded in the table disclose the following facts:—

(1) The effects produced by magnetisation upon the length of an iron wire stretched by a weight are in general of the same character as those which have been shown in the former paper to occur in the case of a free iron rod. Under the influence of a gradually increasing magnetising force such a wire is at first elongated (unless the load be very great), then it returns to its original length, and finally it contracts.

(2) The maximum elongation diminishes as the load increases according to a law which seems to vary with different qualities of iron. If the ratio of the weight to the sectional area of the wire exceeds a certain limit, the maximum elongation (if any) is so small that the instrument fails to detect it.

(3) The retraction due to a given magnetising force is greater with heavy than with light loads.

(4) Both maximum elongation and neutrality (*i.e.* absence of both elongation and retraction) occur with smaller magnetising currents when the load is heavy than when it is light; retraction, therefore, begins at an earlier stage. Thus the anticipation expressed in the author's former paper is justified.

(5) The phenomena, both of elongation and of retraction are, as might be expected, greater for thin than for thick wires, and for soft than for hard iron.

Linnean Society, April 15.—W. T. Thiselton Dyer, C.M.G., Vice-President, in the chair.—The following gentlemen were nominated auditors, viz., J. Jenner Weir and F. Victor Dickins, as representing the Fellows, and Thos. Christy and F. B. Forbes for the Council; afterwards Mr. Rochfort Connor was elected a Fellow of the Society.—Specimens of so-called Madrepore marble from Iowa (U.S.) were exhibited for Mr. G. A. Treadwell. These contained abundance of a species of *Stromatopora*.—Mr. E. A. Heath showed living examples of *Dendrobium densiflorum* and *D. suavissimum*, and Mr. J. G. Baker drawings of new and remarkable ferns in illustration of the Roraima report.—A paper was read on new African genera and species of Curculionidæ by Mr. F. P. Pascoe. These were obtained from Momboia, a missionary station north of Lake Nyassa, from Landana, a new settlement on the Congo, and Mayotte, one of the Comoro Islands off Madagascar. The author remarks that the inadequate descriptions, without reference to affinities or diagnostic characters as given by some entomologists, ought to be disapproved. The great diversity of appearance among the same genus of Curculionidæ is somewhat remarkable; secondary characters, therefore, have to be taken into account, but these, after all, may be quite as natural. On the other hand, species quite like each other in appearance are found to belong to widely different groups. For these and other reasons the correlation of stable characters is perplexing, and definite classification difficult.—The third part of Mr. C. E. Broome's series of fungi from Brisbane, Queensland, was read in abstract.—Mr. Everard F. im Thurn then gave the gist of a long report on the plants collected by him during his recent ascent of Mount Roraima, British Guiana. Among these, 3 new genera and 54 new species had been determined. The country of Guiana was described by him as consisting of three marked ascents from the Atlantic on the east to the central table-land west. The groups of vast sandstone columns, of which Roraima is the best known, really abut or overlap on to Brazil territory, and from their summit pour down streams which flow in diverse directions to feed the rivers Orinoco, Essequibo, and Amazon. Roraima is therefore a probable centre whence peculiar vegetable forms may have originated and distributed themselves over a wide area. Regarding the flora of Guiana as a whole, three distinct zones of vegetation may be distinguished: one, the cultivated strip of coast-land; another, the forest which clothes the upward slopes of the country; and, third, the high savannahs of the interior. Within each of these zones plant species are evenly distributed, though occasionally on the savannahs uniformity is interrupted by small tracts of peculiar vegetation. Sometimes these tracts are marked by the occurrence of only one peculiar species—"areas of localised species"; sometimes by a large number of peculiar species—"areas of distinct vegetation." These latter have notable representatives in the savannah above Karctem Fall and Roraima itself; where, so to say, the more common plant species are excluded. This, then, gives them quite a separate and independent botanical facies.

Entomological Society, April 7.—Mr. Robert McLachlan, F.R.S., President, in the chair.—The following were elected Fellows:—Dr. Capron, Dr. J. W. Ellis, Messrs. F. D. Wheeler, M.A., J. B. Bridgman, F.L.S., T. D. Gibson-Carmichael, F.L.S., J. Rhodes, F.R.M.S., A. C. Horner, J. T. Harris, Evan John, Martin Jacoby, J. A. Clark, G. Elisha, and A. S. Olliff.—Mr. Crowley exhibited a large number of *Lepidoptera* from Accra, West Africa, including long series of *Charaxes* and *Rhomalæosoma*, and a number of specimens of *Saturnia* from Natal.—The Rev. W. W. Fowler exhibited four beetles belonging to the family *Carabidæ*. Three of them had been taken twenty years ago on the banks of the Clyde, and had lately been identified as *Anchomenus sahlbergi*, a species new to Europe, having hitherto been only found in Siberia. The remaining specimen was *Anchomenus archangelicus*, a North European species, nearly related to *A. sahlbergi*.—Mr. J. W. Slater exhibited a spider belonging to the genus *Galeodes*, a Lamellicorn beetle belonging to the genus *Cetonia*, and an undetermined species of *Curculionidæ*, all from Port Elizabeth, South Africa.—Mr. Billups exhibited a specimen of *Bassus bizonarius*, an Ichneumon new to Britain, taken at Peckham in 1885; also a series of another parasite, *Dimeris mira*, taken in Headley Lane, Surrey, in March last.—Mr. White exhibited preserved larvæ of two species of *Catocala*, for the purpose of calling attention to some hitherto undetected processes on the under side; and Prof. Meldola and Mr. J. J. Weir made some remarks on them.—Mr. H. Goss exhibited two remarkable varieties of the male of *Argynnis paphia*, taken in Sussex and Hampshire respectively.—Mr. S. Edwards exhibited an unknown exotic spider found in his Orchid House at Blackheath.—Mr. A. G. Butler communicated a paper entitled "Descriptions and Remarks upon Five New Noctuid Moths from Japan."—The Rev. W. W. Fowler read a paper on new genera and species of *Languriidæ*, chiefly from specimens in the collections of the British Museum, the Cambridge Museum, Mr. G. Lewis, and the Rev. H. S. Gorham; and Dr. Sharp and Mr. Champion made remarks thereon.—Dr. Sharp read a paper on "Some Proposed Transfers of Generic Names," the subject of a pamphlet recently published by M. Des Gozis, in which that author transposed many of the most familiar generic names. Dr. Sharp pointed out the extreme confusion caused by this practice, and showed that the theory on which the system was based was as unsound as the practice itself was objectionable. A long discussion ensued, in which Mr. Fowler, Mr. Waterhouse, Mr. Pascoe, Mr. McLachlan, Dr. Sharp, and Mr. Dunning took part. The last-named gentleman said that the discussion reminded him of a similar one on the application of the law of priority, which took place at a meeting of the Society nearly twenty years ago. The project was then condemned as unanimously as that of M. Des Gozis had been that evening, and he trusted that entomologists would hear no more of it.

Anthropological Institute, April 13.—Prof. A. H. Keane, Vice-President, in the chair.—Mr. H. Ling Roth read a paper on the origin of agriculture. He commenced by briefly reviewing the ideas entertained by savages as to the origin of agriculture among them; then, criticising the views held by scientific men of the present day on the subject, he discussed the conditions generally accepted as necessary to be fulfilled wherever agriculture is to flourish. He laid special stress on the fact that with savages the want of food could not possibly be an inducement to cultivate the soil, but considered that, from the social condition of women in barbarous life and their connection with the soil, they probably originated the first steps which ultimately led whole nations to become agriculturists. He then described what he thought might have been the first step, the rotation in which plants became domesticated, the three homes of agriculture and its spread amongst the uncivilised, and wound up with a few words on the development of agricultural implements.—A paper on the Sengirese, by Dr. Hickson, was read.—The election of Mr. Abraham Hale was announced.

PARIS

Academy of Sciences, April 12.—M. Jurien de la Gravière, President, in the chair.—Complementary note on the results of the application of the prophylactic method against rabies after the bite, by M. L. Pasteur. As many as 726 patients from every part of Europe, and even from North America and Brazil, have now been treated, of whom 688 were for dog-bite and 38 for wolf-bite. Of the first class all are doing well except the already-reported case of the girl Pelletier, and over half of the number have passed the critical period. Of the second class—all Russians—three have succumbed, the others, so far, progressing favourably. An essential difference is pointed out between the nature of bites by wolves and dogs, the former being regarded in Russia as always absolutely fatal. Hence the proportion of victims under the new process must be considered extremely low, more especially considering the severity of the wounds and the long time that elapsed before the treatment could be applied.—On the origin of the electric discharge in thunderstorms, by M. Daniel Colladon. The paper contains a more detailed statement of the author's views, already reported in previous numbers of the *Comptes rendus*, supplemented with remarks suggested by two violent thunderstorms observed by him in the Swiss Alps during the summer of 1885. In the latter an important feature was the *stationary* character of the thunder-clouds, inexplicable according to M. Faye's well-known theory.—Remarks on the second volume of the "Cours de Machines" presented to the Academy by M. Haton de la Goupillière. This volume treats of hydraulics and all kinds of hydraulic machinery, with a special chapter on accumulators and their various applications.—Note on a photographic map of the Pleiades group, by MM. Paul and Prosper Henry. This chart is an engraved reproduction of a proof on paper of the impression obtained on November 16, 1885, by means of the 0·33m. photographic equatorial twice enlarged. It shows, besides the interesting nebula near Maia, another near Electra, of which a very faint impression was obtained. It also indicates the existence of several new companions to Merope, Alcyon, and some other brilliant stars. The discrepancies between this map and Wolf's tables are most pronounced in the case of the small stars in the vicinity of brighter constellations. One of the 10th magnitude in Wolf's list is resolved in the photographic into two of the 13th magnitude. It is also pointed out that where direct observation gives only 625, the photographic process reveals 1421 stars in a somewhat smaller space.—On some remarkable spectroscopic phenomena, by M. A. Riccò. While recently observing on a very bright protuberance the inversion of the sodium rays D and D_2, the author was surprised to notice that the very vivid chromospheric ray D_3 seemed double, being divided by a very fine black line. The same effect was afterwards observed on the chromospheric rays C and F, and it is suggested that these and other double inversions noticed from time to time on the sodium and magnesium rays may be connected with the phenomenon of diffraction.—On the origin of M. Janssen's "solar photospheric network," by M. G. M. Stanoiewitch. From his studies of the photosphere the author concludes that, whatever be the origin of the solar granules, the "photospheric network," as presented by the photographic plates, does not exist on the surface of the sun. It is produced by the irregular refraction of a transparent body with irregular molecular constitution interposed between the granular solar surface and the photographic objective. This irregular refraction is caused by the gaseous envelope of the sun, which, being agitated by currents in all directions, presents as a whole a body of extremely irregular molecular constitution. This view was not accepted by M. Janssen, who made some remarks after the paper was read.—On the equilibrium of a fluid mass in rotation, by M. Matthiessens. The author claims priority of discovery of the annular figures which M. Poincaré lately stated had first been observed by the English geometricians Tait and Thomson. He refers to a series of papers ranging from 1845 to 1883, in which he describes the two rings and discusses the whole theory of these forms and of the ellipsoidal figures.—On a general theorem relating to the propagation of motion, by M. Hugoniot. The method employed by the author in studying the propagation of motion in fluids is here generalised and extended to all movements regulated by the same system of mathematical formulas. —On the thermo-electric properties of iodide of silver, phosphuret of zinc, sulphuret of tin, and some other chemical compounds, by M. G. Chaperon.—On the density and compressibility of gases and vapours, by M. Antoine. The compressibility of atmospheric air is shown to approach that of nitrogen, whence an important induction is drawn for the use of automatic torpedoes in marine warfare.—On the optical phenomenon known as simultaneous contrast, that is, the tendency to produce the sensation of a complementary colours in the neighbourhood of any coloured surface, by M. Aug. Charpentier. From his researches the author infers that this phenomenon of contrasting colours produced in a region not directly excited is simply a case of *induced colours* in the literal and figurative sense of the expression.—Transformation of the protochloride of chromium into a sesquichloride : molecular states of the oxides of chromium, by M. Recoura.—On monochlorurretted vinylethylic ether, trichlorurretted, pentachlorurretted, and some other chlorurretted ethers, by M. L. Godefroy. The first-mentioned of these ethers, discovered by the author, has enabled him to prepare six other ethers, some already known, some new, and forming two distinct series with almost opposite general characteristic properties.—A study of the isomeric naphthylphenylcarbonyls, by M. Rospendowski.—On the eleven genera of the land Lumbricus established by Kinberg, by M. Edm. Perrier. Most of these so-called genera are shown to be mere species, and all the genera known in the time of Kinberg, or down to the year 1872, are now reduced to four. To these are here added eleven others, making fifteen at present known.—On the food of turtles, by MM. G. Pouchet and J. de Guerne. Although usually supposed to be herbivorous, the stomach of some turtles captured in the Azores waters yielded remains of *Hyalæa tridentata*, *Lepas anatifera*, besides Medusæ and small fishes.—Note on the discovery of a Cenomanian deposit at Pech de Foix, containing *Pygaster truncatus*, *Rhynchonella grasiana*, and other fossils of the same epoch, by M. J. Roussel.—Experimental essay on the toxic properties of febrile urines, by M. V. Feltz.—Note on the project of a railway from the coast of Syria to the Persian Gulf, by M. A. Dumont. The projected Euphrates Valley scheme connecting the Mediterranean with the Persian Gulf is favourably discussed from the engineering and economic standpoints. This alternative overland route is declared to be a necessity in the near future, in consequence of the continually increasing traffic through the Suez Canal. At the conclusion of the paper M. de Lesseps also spoke in favour of the scheme, which might be carried out for about 10,000,000*l*.

GOTTINGEN

Royal Society of Sciences, Aug. 1, 1885.—On the theory of liquid jets, by W. Voigt.—The spectrum of the brush discharge, by E. Hoppe. The lines showed a certain correspondence to those of aurora.—On the pyro-electricity of tourmaline, by E. Riecke. The method was to heat a tourmaline a given time in a space of high constant temperature, then hang it by a cocoon fibre to cool near the knob of a gold-leaf electroscope, whose behaviour was then noted. In cooling, the maximum of electric charge occurs if the tourmaline has first taken throughout the temperature of the heating space. The charge corresponding to a regular heating is nearly the same as that with an irregular, if the mean temperature of the latter be equal to the constant temperature of the former.—On Crinoids, by H. von Könen.

November 7.—On a representation of elliptic modulus functions, by infinite products, by H. von Mangoldt.—On Maccullagh's theory of total reflection for isotropic and anisotropic media, by P. Volckmann.

STOCKHOLM

Academy of Science, March 12.—Report on a visit to the Continent for the study and research of chemicals, by Dr. J. M. Lovén.—On Biunclearia, a new genus of Confervaceæ, by Prof. Wittrock.—On *Erythrææ exsiccatæ*, V. B. Wittrock.—Report on a visit to the province of Jemtland (Sweden) for the prosecution of mycological studies, by Herr C. J. Johansson.—Report on a visit to the province of Scania for the prosecution of bryological studies, by Dr. A. L. Gröuvall. —On the formation of zoospores and quiescent spores in some species of the genus Conferva, by G. Lagerheim.—On the "Herbarium Ruborum Scandinaviæ" of Dr. C. J. Lindeberg, by Prof. Wittrock.—Report on a visit to Ireland, the North of France, Holland, and Westphalia, in order to study the Cretaceous formations of these countries, by Dr. J. C. Moberg.—On a discussion with a view to prove the stability of the planetary system, by Prof. H. Gyldén.—Sur une formule dans la théorie des fonctions, by Prof. Pincherlè of Bologna.—Annotations on the mathematician Petrus de Dacia, and on writings (third part), by Dr. G. Eneström.—On a geological map of Scandinavia, Denmark, and Finland, exhibited and commented upon by Prof. O. Forell.—On the classification of tourmaline with the group of the rhombohedric tetartohedric forms of the hexagonal system, by Dr. W. Ramsay.

BOOKS AND PAMPHLETS RECEIVED

"The Fresh-water Fishes of Europe," by H. G. Seeley (Cassell).—"Traité de la Détermination des Orbites des Comètes et des Planètes," by A. Oppolzer (Gauthier-Villars).—"Templeton's Workshop Companion," enlarged by Hutton (Lockwood).—"Report of the Mitchell Library, Glasgow, 1885" (Anderson).—"Il Grande Ipnotismo," by Dr. G. Campili (Bocco, Turin.)—"Sound, Light, and Heat," by C. Bird (Relfe).—"Gardens of Light and Shade" (Stock).—"Encyclopædia Britannica," vol. xx. (Black) —"On Asthma," by Dr. H. Dobell (Smith, Elder, and Co.).—"Journal of the Royal Microscopical Society," April (Williams and Norgate).—"Mechanics and Faith," by C. T. Porter (Putnam).—"Systematische Übersicht der FossilenMyriopodenArachnoideen und Insekten" i. Abth., Bd. ii., by S. Scudder (München).—"Journal of the Society of Telegraph-Engineers and Electricians," vol. xv. No. 60 (Spon).—"Verhandlungen der Naturhistorischen Vereines," second year, part 2 (Max Cohen, Bonn).—"The Auk," April (Foster, New York).—"Journal of the Asiatic Society of Bengal," vol liv. part 2, No. 3, 1885 (Calcutta).—"American Museum of Natural History," Annual Report of the Trustees, &c., for the Year 1885-86 (Martin, N.Y.).—"Johns Hopkins University: Studies from the Biological Laboratory," vol. iii. No. v.—"The Influence of Sewerage and Water Supply on the Death Rate in Cities," by E. T. Smith.—"What is Materialism," by L. Stephen (E. W. Allen).—"Charles Darwin," by H. W. S. Worsley-Benison (Seers, Bath).—"Les Orages au Sud de la Russia," by A. Klossovsky (Odessa).

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THURSDAY, APRIL 29, 1886

FLOWERS, FRUITS, AND LEAVES

Flowers, Fruits, and Leaves. By Sir John Lubbock, Bart., M.P., &c. "Nature Series." (London: Macmillan and Co., 1886.)

THE President of the Linnean Society sets a good example. Not many men, we suppose, have more onerous or more multifarious duties than he. He earns his leisure, little though it be, and he makes excellent use of it. Flowers, fruits, and leaves, to say nothing of insects and archæological investigations, supply him with the recreation he needs, provoke his observation, and stimulate his intelligence. More than that, they make him a propagandist. He is anxious to share with others the pleasure and relief he obtains from the study of Nature. To this end he descends from the Presidential chair to converse familiarly on the objects of his study, not only with those who are already in sympathy with him, but with those benighted Philistines whom perchance he may yet hope to gather into the fold. The substance of the book before us formed the basis of certain lectures addressed to popular audiences, and is well suited, with the accompanying illustrations, to arouse the attention of the indifferent and of that very large class of persons who go through the world with their eyes shut.

Two of the lectures, those on "Flowers," have been previously published. They contain references to the relationships between insects and flowers, to the visitations of the former to the latter, and other cognate matters with which the reading public has been familiarised. We need therefore only allude to the remaining chapters, treating of "Fruits and Seeds" and of "Leaves." The terms are throughout used in their popular and not in their strict technical acceptation, a circumstance which at once brings under notice the very different means by which the same effect or purpose is fulfilled. The general reader concerns himself far more with results than with the way in which they are brought about, and hence he sees no incongruity in grouping the winged flower-stalk of the lime, the "keys" of the ash or the maple, and the winged seed of the pine under one and the same heading.

Sir John humours this tendency. Probably he feels that the majority would be repelled by morphological disquisitions, genealogical dissertations, and transcendental speculations. These things come after. For the present the author dilates upon the form and appearance of the fruit and seed in relation to the necessities of their life and the purpose of their existence. He thus points out, on the one hand, the modifications and adaptations to secure adequate protection for the seed from the vicissitudes to which it is exposed, and, on the other, the divers means by which the dispersion of the seed is effected and its germination facilitated. Similarly, in the case of the leaves, the author discusses the probable causes of the exuberant variation met with in these organs. Whatever the cause, the result is doubtless consistent with the principle expressed by "the greatest happiness of the greatest number," the co-relations and adaptations met with secure the maximum of advantage possible to each leaf with the least interference with the requirements of neighbouring leaves. It is not often we should be disposed to cite Mr. Ruskin as an authority on botanical matters, but in the fifth volume of his "Modern Painters" he has to some extent anticipated Sir John, and given some striking illustrations of the mutual adjustments between the several leaves on the same branch.

The protection possibly afforded by the close resemblance of one plant (unprovided with other means of defence) to another duly equipped with defensive armour was not thought of in pre-Darwinian days. Sir John Lubbock in the volume before us gives several illustrations of the phenomenon which, whether we accept the explanation or not, are very striking. Attention is also called to the primordial leaves which succeed to the cotyledons or seed-leaves. In many cases, as in conifers and in most compound-leaved plants, the form of these adolescent leaves differs widely from that of the adult foliage. From these circumstances the obvious inference is drawn that plants with lobed or compound leaves are derivatives from ancestors that had leaves of simpler type. The seedling plant in such cases is assumed to repeat the form and appearance of its ancestors. If this inference is taken in a general sense, and not made too exclusive in its application, it will meet with general acceptance. But we do not think that we are entitled to assume direct genetic connection in all such cases. Of necessity simple leaves must precede divided or compound ones. Similarity of conditions and requirements would bring about, in the case of archaic and of recent plants respectively, similarities of form without any necessary direct hereditary connection between the two.

A few slips may be mentioned for correction in the next edition; thus, it is hardly correct to describe the leaves of *Desmodium gyrans* as perpetually moving round (p. 49); Stael (p. 114) should be Stahl; and the reference (at p. 93) to "Mr. Moore" requires further differentiation, as there are several Moores known to botanists. In this case Spencer Le Marchant Moore is probably intended.

We have said enough to show what varied sources of interest are opened up by Sir John Lubbock in this book. We trust that in future we may have further discussions of like nature from his pen, and we might suggest to him, as a complement to what he has here given us, a chapter on the significance of the various modifications of leaf-arrangement met with in Buds.

MAXWELL T. MASTERS

THE GEOLOGY OF PALESTINE

Memoir on the Physical Geology and Geography of Arabia Petræa, Palestine, and Adjoining Districts. By Edward Hull, F.R.S. (Under the auspices of the Committee of the Palestine Exploration Fund. 1886.)

MUCH has been written in recent years regarding the geology and natural history of that deeply interesting region which lies to the east of the Gulf of Suez, and includes the Basin of the Jordan River. Yet much still remains for further exploration, more especially in the way of more accurate detail and of connected analysis of the whole region. Recognising this deficiency of information, the Committee of the Palestine Exploration Fund towards the close of the year 1883 organised an expedition for the purpose of making a geological survey, or rather reconnaissance, of Western Palestine, and intrusted its conduct to Prof. E. Hull of the Geological Survey. The Report of this expedition is now issued as a handsome quarto volume of 145 pp., with maps and numerous woodcuts. Part I. gives an enumeration of the more important or accessible writings of previous observers, and a description of the physical features of the districts visited. Part II. deals with the geological structure of Arabia Petræa and Palestine, including the Archæan crystalline rocks, and the Carboniferous, Cretaceous, Tertiary, and Post-Tertiary formations. Part III. contains a brief account of the Tertiary Volcanic Rocks. Part IV. is devoted to a discussion of the dynamical operations which may have brought about the present geological structure of the region, and of the evidence of former differences of climate. Part V. treats of the origin of the saltness of the Dead Sea and of the recent climatal changes of that district. The scheme of treatment is thus comprehensive enough, and the details and conclusions are clearly expressed, though they hardly add as much as could have been hoped to what was already known on the subject. The discussion of the dynamical questions is disappointingly meagre. In the problem of the origin of the great Jordan Valley depression there was room for much detailed exposition, wherein a careful collection of the facts of geological structure could have been made conducive to a valuable addition to our knowledge of this important and still obscure branch of geological physics. The history of the surface-features of the region of Western Palestine is a question on which the Report throws very little fresh light, though it is the one to which perhaps above all others the members of a flying corps of observation might have been expected to be able to contribute valuable data. Regarding the changes of climate and the origin of the Dead Sea we should have looked for more new materials and a much fuller discussion than the few paragraphs in which this important subject is dismissed. No doubt Prof. Hull and his companions did as much in the way of observation during their brief visit as was possible in the time, and he has made all that probably could be made of it in this Report. But we are inclined to think that the subject was in such a position that little further could be usefully done to it by the rapid journey even of a trained observer through the country. If the Committee of the Palestine Exploration Fund want to have a satisfactory solution of the many profoundly interesting geological problems presented by Syria and Palestine, they must organise the task as part of the less rapid and more detailed survey of the general topography. The Report is excellently printed and illustrated, the maps being of especial value, containing as they do a summary of all that is known up to the present time regarding the distribution of the rocks in Palestine. There are some errors of the press which on revision the author will no doubt correct in another edition, and we would call his attention to a sentence which betrays his nationality, "The Patriarch Job, whether an actual person or a representative character, may be supposed to have inhabited the Plains of Edom" (p. 123).

A MANUAL OF CHEMISTRY

A Short Manual of Chemistry. Vol. I. "Inorganic Chemistry." By A. Dupré, Ph.D., F.R.S., F.C.S., &c., and H. Wilson Hake, Ph.D., F.C.S., F.I.C. (London: Charles Griffin and Co., 1886.)

"WHY should another hand-book on this subject be added to the many which already exist in the language?" In the first paragraph of their preface the authors anticipate the possibility of this question arising in the minds of some chemists, and they therefore answer it by (1) claiming their right, as teachers of lengthened experience, to record their methods of instruction; and (2) expressing their belief "that the very multiplicity of text-books already published tends to show a want felt, but not yet satisfied."

Their method consists in first laying down general principles which, when thoroughly mastered, are to be followed up with the facts of descriptive chemistry.

The introductory chapters containing these general principles, on which the student "with no previous knowledge of chemistry whatever" is to found his chemical education, comprise about 80 pages of the book, and since the authors lay so much stress on their importance, we cannot pass over this portion of the book without giving a few illustrations of what is to be learnt from the manual apparently intended to supersede all other text-books.

The representation of a molecule by two small circles surrounded by a larger circle (see note on p. 11) may perhaps be mentioned as an instance of the pertinacity with which so many teachers continue to do their best to confuse their pupils with erroneous conceptions of atoms and molecules.

On p. 36 the melting-point of a substance is incorrectly defined as "the temperature at which it is no longer capable of existing as a solid." On p. 37 it is stated that "most substances increase in volume on melting, but some decrease. In the case of the former the effect of pressure is to lower, in the latter to raise, the melting-point." Thomson proved the opposite of this to be the case.

The statement generally found in text-books that a ray of light passing from a rarer to a denser medium is refracted towards the perpendicular, and *vice versâ*, is reproduced on p. 42. If the authors are employing the word *dense* in the optical sense, we think they should say so, if in the ordinary sense, the statement is incorrect.

On p. 43 they describe *total reflection* as taking place when "a ray of light proceeding from a denser to a rarer medium strikes the surface, separating the two media at such an angle that the refracted ray would form a right angle (or any greater angle) with the reflected ray." We would like to know the authority for this curious statement.

On pp. 64 and 65 is a table headed "Table of Symbols, Atomic and Molecular Weights, and Valency of the Elements." It contains a list of all the elements, including those most recently discovered, norwegium amongst the rest, though the existence of the latter metal cannot be said to have been satisfactorily demonstrated. The columns to which we more particularly call attention are, however, those headed "molecular symbol, showing number of atoms in the molecule," and "molecular weight." Every element has a molecular symbol and a molecular weight assigned to it. Carbon, for instance, is represented by the molecular symbol C_2 and by the molecular weight 28. Now, on pp. 58 and 59 the reader is given to understand that the molecular weight of a substance is the specific gravity of the gas or vapour multiplied by 2 (the sp. gr. of hydrogen being taken as unity). On p. 130 it is further stated that carbon in all its forms is non-volatile. How then is the unfortunate student, or, in fact, any one else, to reconcile these statements with that found in the table that the molecular weight of carbon is 28, and what applies to this element applies of course to most of the others. We may also mention that in another part of the book (p. 160) a molecule of carbon is represented as consisting of twelve atoms. This may of course be a printer's error, but we find the same want of system in symbolic representation throughout the book.

We entirely agree with the authors that Inorganic Chemistry should receive more attention at the hands of chemists, but how is it that the authors do so little justice to what has been done in this branch of chemistry? Garzarolli-Thurnlackh's proof of the non-existence of chlorous anhydride is simply ignored, and the statements found in most text-books with reference to this imaginary compound are again reproduced. The action of nitric acid on the metals is also represented by the usual text-book equations.

A good feature in the book is the arrangement of the properties, &c., of the substances described under different headings, which are convenient for ready reference.

There are many more points to which we might refer if space allowed, but we think we have said enough to indicate that in our opinion, at least, this new manual is not calculated to supply the "want felt, but not yet satisfied."

OUR BOOK SHELF

Technical Gas Analysis. By Clemens Winkler, Ph.D. Professor in Freiberg. Translated by George Lunge, Ph.D. (London: Van Voorst, 1885.)

PROF. LUNGE has rendered another service to the world of chemists, both students and practical men, in translating Winkler's small book on "Gas Analysis." We have here a really practical work which a man may use in a works or a teacher or student in a laboratory.

Winkler's book is scarcely known in this country, and we may venture to say that several, if not most, of the gas apparatus figured and described in this book are also scarcely known.

The book is decidedly practical, and treats in the first instance of methods of collecting gases; on measurement of gases; and on apparatus and methods of analysis. The translator has added a chapter on the nitrometer, and shows how it may be used for more extended analyses than the examination of nitrous vitriol. An appendix of useful tables makes the book a very valuable laboratory companion.

Lessons in Elementary Chemistry, Inorganic and Organic. By Sir Henry E. Roscoe, LL.D., F.R.S., Professor of Chemistry in the Victoria University, Owens College, Manchester. New Edition. (London: Macmillan and Co., 1886.)

THIS favourite text-book is so well known to students of chemistry that, whilst calling attention to the appearance of a new edition, we need only remark that the author has introduced several changes and additions which bring the book as well up to date as the limits of a work of this size will permit.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

New System of Earthquake Observations in Japan

OWING to the invention of new seismographs by the members of the Seismological Society of Japan, there has been of late a complete change in the system of earthquake observations in this country. The Meteorological Bureau now employs the horizontal pendulum and vertical-motion seismographs of Profs. J. Milne and T. Gray, and of Prof. J. A. Ewing for systematic observation, while the Imperial University of Tokio publishes from time to time detailed accounts of particular and more interesting shocks by the use of similar instruments. These seismographs register on a revolving glass plate or drum automatically started by the earthquake motion, components of horizontal and vertical motions of the earth on a magnified scale, thus producing continuous diagrams, and indicating successive displacement of the ground in conjunction with the time.

The account of the earthquake of December 28, 1885, the largest shock during the last three months, is here given as a sample of seismic record now issued in this country. The meanings of the terms employed are as follows: a, semi-amplitude of seismic wave; T, period of complete wave; V, maximum velocity in mm. per sec., or $\frac{2\pi a}{T}$; α, maximum acceleration in mm. per sec. per sec. or $\frac{V^2}{a}$.

At the Imperial University of Tokio, Japan, at 10*h.* 6*m.* 30*s. on December* 28, 1885

Maximum semi-amplitude of horizontal motion a_1 ...	1·8
Complete period T_1 corresponding to the max. horizontal motion	1·5
Maximum semi-amplitude of vertical motion a_2 ...	0·3
Complete period T_2 corresponding to the max. vertical motion	0·6
Direction of the max. horizontal motion	E.–W.
Duration	3m. 30s.

Remarks.—The motion slowly commenced, not accompanied by quick tremors, as is usually the case. At the 14th second from the commencement a considerable E.–W. motion occurred; in another second the maximum movement appeared in the same direction, which was followed by smaller shocks during about one minute; and from thence the oscillations gradually subsided. As usual, the particles of the ground did not move to and fro, but traced a curvilinear path, although the E.–W. components always remained greater than the S.–N. components. In all, over 130 shocks or complete waves were registered.

From figures given in the above table, the maximum velocity V and the maximum acceleration α may be calculated, which are, in this case for the horizontal motion, 7·6 mm. per sec. and 39 mm. per sec. per sec. respectively. The latter quantity is the measure of the *intensity* of the earthquake, and may be employed in determining the overthrowing power of body and shattering and other destructive effects produced on buildings. Although the records given by the oscillations of fluids, fissures on walls, rattling of wine-glasses, &c., might tell something about the nature of earthquakes, and are indeed invaluable in absence of suitable instruments, yet for the *absolute* measure ments of seismic force the method above cited, I believe, is by far the best that has ever been attempted on this subject.

I may add in respect to the above earthquake, and in general, that the vertical motions are always—in our experience—smaller than horizontal ones, and the maxima and minima of these two kinds of motions are not synchronous. I shall have occasion before long to communicate to you the general results of all observations made during past years.

An equally interesting set of observations carried out by the Meteorological Bureau was the determination of areas shaken in every earthquake, together with the reductions of results during the years 1885-86—the works of which I was directed to superintend. The method followed out was almost exactly the same as that originated by Prof. J. Milne in studying "387 earthquakes in North Japan," an epitome of which appeared some time ago in your columns. This method is briefly as follows. Observation-books furnished with directions for reporting earthquake phenomena with or without instruments were distributed, authorised by Government, among over 600 local offices throughout the empire; in fact, the earthquake observations were made a part of the duty of local officers, and the reports were transmitted free of postage. From the reports sent in by different observers thus closely stationed, maps have been made showing the disturbed area in every shock, and a summary of observations has been compiled.

The results worked out from a large number of these maps and their notes have revealed many interesting facts, and entirely confirmed the previous works of the eminent seismologist above mentioned.

The total number of earthquakes in Japan in 1885 was 482, equivalent to 1·3 shakings a day. In Tokio alone 68 shocks were registered. Earthquakes are most prevalent in Yezo, and the north and central portions of the main island along the eastern or the Pacific coast, but in provinces bordering the Japan Sea they are few, and in some places none at all; if they occur, they are generally limited to small tracts of land. Speaking of the main island in general, the range of mountains traversing through and forming the backbone of Central Nippon appears to divide it into two zones of different seismatic activities. In Kiushū, Shikoku, and other islands, disturbances are comparatively small.

Most larger earthquakes originate beneath the ocean. The majority of shocks are only local. Of the whole number, 235 local disturbances were recorded, which have not extended more than 100 square miles of land area. The maximum area of *one* earthquake was 34,700 square miles. The aggregate area of disturbance during the year was 796,000 square miles, and taking the total area of the empire to be 147,000 square miles, it is equivalent to saying that the whole of Japan has been shaken 5·4 times in one year. In summer shocks are less prevalent than in winter. The earthquakes occur in groups, that is to say, when disturbances occur, they are limited within certain portions of country, not generally extending beyond these limits. Propagations of seismic waves are often stopped by mountain-chains.

Finally, I may state that we shall continue these observations in future, and I hope the results to be obtained from more years' work of this nature will be some help in throwing light on the physics of the earth's crust. SEIKEI SEKIYA

The Imperial University of Tokio, Japan, February 28

"The Krakatão Dust-Glows of 1883-84"

IN your issue of March 25 (p. 483) the writer of the critical notice of Dr. Riggenbach's pamphlet on the above propounds a statement which, if true, is of vast importance in accounting for the subsequent optical phenomena which are supposed to have been connected with the eruption. He says: "Thus the hurling into the air of 150 cubic kilometres of volcanic dust in August 1883," &c. Whence does he deduce this enormous quantity? M. Verbeek, in his "Krakatão," part 1, which I have carefully perused, estimates the entire volume of ejecta (chiefly based on what fell near the spot) at only 18 cubic kilometres, and as his work is the only reliable source of information regarding the eruption with which I am acquainted, I am entirely at a loss to conceive how the 18 has been suddenly magnified into 150.

As one of the Krakatão Committee of the Royal Society, I have naturally examined the theoretical possibility of the amount of dust ejected having been sufficient to account for the optical phenomena witnessed, and have been obliged to content myself with the very modest quantity of 4 cubic kilometres out of the total 18, but if your writer's statement is correct, I am evidently at liberty to considerably augment the quantity at my disposal, and it is needless to say that this would seriously change the aspect of the question. E. DOUGLAS ARCHIBALD

April 15

Pumice on the Cornish Coast

Is Mr. Guppy sure that the "pumice" he records in NATURE for April 15 (p. 559), as found on Maenporth Beach, is the natural article? I ask because of having been accustomed to find pieces of a pumice-like stone, many light enough to float on the sea, along the Suffolk coast. This, however, is an artificial product, a sort of cinder from steamers, though it has deluded many people. It puzzled me for some time.

W. WHITAKER

33, East Park Terrace, Southampton

Ferocity of Animals

IF your correspondent in last week's NATURE (p. 583) will treat a wild rat in the way which I described, the animal will answer his question much more effectually than I can. For while I have only words at my disposal whereby to convey any "ejective" information upon the subject, the rat will display the fact of his understanding your correspondent's intention by a thousand co-ordinated movements of a much more eloquent kind.

The paper by Mr. Lloyd Morgan in the current issue of *Mind* is merely a republication of his views as already presented in this periodical. Having replied to these views as fully as seemed to me desirable when they were first expressed, it is needless that I should now go over the same ground a second time. It will, therefore, be sufficient to refer your correspondent to the discussion between Mr. Morgan and myself, which he will find in consecutive issues of NATURE for February and March 1884.

GEORGE J. ROMANES

The Climbing Powers of the Hedgehog

I REMEMBER many years ago we kept a hedgehog on the Continent in an upper garden well walled in. There she remained for some time, until she littered four or five young in a rubbish heap in a corner. The young having grown, and being able to move about, she and her whole brood disappeared. Her only way was over a wall four or five feet high, on which she left traces, but the young could not have been able to climb this, and she must have carried them. HYDE CLARKE

32, St. George's Square, S.W.

ON THE LAW OF THE RESISTANCE OF THE AIR TO THE MOTION OF PROJECTILES

IN my experiments made to determine the resistance of the air to the motion of projectiles, it was assumed that this resistance followed *some law* producing a gradual change in the velocity, and consequently that the times occupied by the shot in passing over a succession of equal spaces would admit of being differenced. This method of proceeding gave the required result in the form of a coefficient K_v of v^3, in terms of the second and higher differences of time above referred to, when the time was expressed in seconds to five places of decimals. So long as this value of K remains constant, the resistance of the air varies as the *cube* of the velocity The first results obtained were published in a note in the *Phil. Trans.* for 1868, p. 441. The experiments were afterwards more carefully calculated, and given in detail in the Reports published by Government in 1870. In using these results to calculate general tables for space and time, for cases where the projectile could be supposed to move approximately in a straight line, and free from the action of gravity, the corrected mean values of K_v were used, and made to vary with the corresponding velocity v. And in my "Treatise on the Motion of Projectiles" (1873), the *cubic* law of resistance was used for the purposes of calculation, so that for those velocities where K varied it was necessary to divide the trajectory into such small arcs that, throughout each arc, the average value of K could be used without sensible error. This treatment of the question rendered it unnecessary for me to attempt to express the law of resistance according to powers of v for all practical velocities. But from the results of my experiments for velocities between 900 and 1700 f.s., I remarked that "the resistance of the air may be considered to vary roughly as the *sixth* power of the velocity for velocities 900-1100 f.s., to vary as the *third* power for velocities 1100-1350 f.s., and to vary as the *second* power for velocities above 1350 f.s. (*Proc.* R.A. Inst., September 1871).

Further experiments were made in 1878-80, which furnished the values of K for velocities from 100 to 2800 f.s., as published in Reports, 1879 and 1880.

I now propose to express the resistance of the air to the motion of ogival-headed shot ($1\frac{1}{2}$ diam.) in terms of v^2, v^3, and v^6, according to the values of v. The Newtonian law of retardation is given by $-\frac{d^2}{w}k\left(\frac{v}{1000}\right)^2$; the cubic law by $-\frac{d^2}{w}K\left(\frac{v}{1000}\right)^3$; and the law of the 6th power by $-\frac{d^2}{w}L\left(\frac{v}{1000}\right)^6$, where d denotes the diameter of the shot in inches, and w its weight in pounds. The values of K_v used in the tables given below (I. to V.) are those given directly by experiment, as published in my Reports of 1870 and 1880, with the exception that the values of K_v for velocities between 1080 and 1580 f.s. have been increased by 0·68 per cent., to render the density of the air uniform throughout.

The points of division in these tables are somewhat arbitrary, and if they should be passed a little either way the practical error will not be large. Capt. Ingalls, of the U.S. First Artillery, has deduced very similar coefficients from my experiments, which he has published in his "Exterior Ballistics" (1885).

In another place I have shown (*Proc.* of the R.A. Inst., 1885) how K may be corrected: (1) for density of the air, by the introduction of a factor τ; (2) for steadiness of the shot by a factor σ; and (3) for a different form of head, by a factor κ. The corrected value of K thus becomes $K\tau\sigma\kappa$. And the same form of correction will apply to the coefficients k and L.

It must be remarked that the values of K for high velocities were derived from the motion of shot fired at low elevations. Consequently, in calculating ranges for comparison with experimental ranges, &c., the best agreement may be expected for low elevations of 1° to 4° or 5°. But when the muzzle velocity is high and the elevation considerable, there are several disturbing causes to be considered.

The elongated projectile has a tendency to preserve the parallelism of its axis, but this soon becomes inclined to the direction of motion of its centre of gravity, and hence arises a lateral pressure from below, which gives rise to a gyratory motion of the shot. The effect of this upon the shot is to increase the resistance of the air, to give a lateral "drift," and probably a still greater vertical "drift," because the *first* lateral disturbing pressure is from below.

When the projectile rises to a great height the density of the air decreases, and the resistance of the air is consequently diminished.

The direction of the initial motion of a shot is commonly not that in which the gun is pointed, but is affected by an error called the "jump."

All these errors tend generally to increase the range, except that, when the axis of the shot is oblique to the direction of motion, the resistance is increased. But it is evident that the direction of the axis of the shot does not differ much from the direction of the tangent to the trajectory, because the holes made in targets appear practically circular.

And, further, guns have different shooting qualities, and t is said that two guns of the same type do not shoot alike. One gun may be superior to another for one charge and be inferior for a different charge, as our experiments clearly showed. I mention these matters to show that we cannot expect an *exact* agreement in all cases between calculation and experiment.

TABLE I.—RESISTANCE $\propto v^2$

v f.s.	Experimental K_v	$\frac{vK_v}{1000} = k_v$	Error	v f.s.	Experimental K_v	$\frac{vK_v}{1000} = k_v$	Error
430	132·9	57·1	− 4·2	670	100·2	67·1	+ 5·8
440	132·9	58·5	− 2·8	680	98·4	66·9	+ 5·6
...	...	...	...	690	96·9	66·9	+ 5·6
460	138·2	63·6	+ 2·3	700	87·7	61·4	+ 0·1
470	147·0	69·1	+ 7·8	710	81·8	58·1	− 3·2
480	164·6	79·0	+ 17·7	720	83·6	60·2	− 1·1
...	...	...	...	730	72·8	53·1	− 8·2
530	117·2	62·1	+ 0·8	740	78·8	58·3	− 3·0
540	113·1	61·1	− 0·2	750	83·1	62·3	+ 1·0
550	109·5	60·2	− 1·1	760	83·9	63·7	+ 2·4
560	97·4	54·5	− 6·8	770	85·7	66·0	+ 4·7
570	101·9	58·1	− 3·2	780	81·0	63·2	+ 1·9
580	95·9	55·6	− 5·7	790	72·1	57·0	− 4·3
590	109·0	64·3	+ 3·0	800	61·4	49·1	− 12·2
600	111·6	67·0	+ 5·7	810	60·7	49·1	− 12·2
610	107·6	65·6	+ 4·3	820	66·5	54·5	− 6·8
...	...	..	...	830	75·5	62·7	+ 1·4
650	94·5	61·4	+ 0·1	840	75·1	63·1	+ 1·8
660	97·0	64·0	+ 2·7	850	70·7	60·1	− 1·2

Mean value of k = 61·3 for velocities under velocity 850 f.s.

As it was impossible to carry out experiments for velocities below 430 f.s. in the usual way, special experiments were made with elevations of 45° and muzzle velocities 420-140 f.s. The ranges and times of flight were calculated on the supposition that the above law held for velocities below 430 f.s. (Final Report, pp. 7, 48, 49). As the agreement between calculation and experiment was satisfactory, it was concluded that the above found law was good for velocities 100 to 850 f.s.

TABLE II.—RESISTANCE $\propto v^3$.

v f.s.	Experimental K_v	Error	v f.s.	Experimental K_v	Error
850	70·7	− 3·7	950	76·1	+ 1·7
860	68·6	− 5·8	960	73·8	− 0·6
870	65·2	− 9·2	970	73·6	− 0·8
880	65·7	− 8·7	980	73·5	− 0·9
890	75·3	+ 0·9	990	74·6	+ 0·2
900	81·6	+ 7·2	1000	74·6	+ 0·2
910	79·7	+ 5·3	1010	74·6	+ 0·2
920	77·6	+ 3·2	1020	74·2	− 0·2
930	76·3	+ 1·9	1030	75·1	+ 0·7
940	73·3	− 1·1	1040	84·0	+ 9·6

Mean value of K = 74·4 between velocities 850 and 1040 feet per second.

TABLE III.—RESISTANCE $\propto v^6$.

v f.s.	Experimental K_v	$\left(\frac{1000}{v}\right)^3 K_v = L_v$	Error
1040	84·0	74·7	− 4·5
1060	92·1	77·3	− 1·9
1080	106·0	84·1	+ 4·9
1100	107·2	80·5	+ 1·3

Mean value of L = 79·2 between velocities 1040 and 1100 feet per second.

TABLE IV.—RESISTANCE $\propto v^3$.

v f.s.	Experimental K_v	Error	v f.s.	Experimental K_v	Error
1100	107·2	− 1·6	1220	110·3	+ 1·5
1120	106·0	− 2·8	1240	108·7	− 0·1
1140	109·0	+ 0·2	1260	109·4	+ 0·6
1160	109·7	+ 0·9	1280	111·2	+ 2·4
1180	109·5	+ 0·7	1300	109·3	+ 0·5
1200	106·5	− 2·3			

Mean value of K = 108·8 between velocities 1100 and 1300 feet per second.

TABLE V.

v f.s.	Experimental K_v	$\frac{vK_v}{1000} = k_v$	Error	v f.s.	Experimental K_v	$\frac{vK_v}{1000} = k_v$	Error
1300	109·3	142·1	+0·6	2120	67·6	143·3	+ 1·8
1320	108·0	142·6	+1·1	2130	67·8	144·4	+ 2·9
1340	106·3	142·4	+0·9	2140	67·5	144·5	+ 3·0
1360	105·6	143·6	+2·1	2150	67·5	145·1	+ 3·6
1380	105·9	146·1	+4·6	2160	67·1	144·9	+ 3·4
1400	105·0	147·0	+5·5	2170	67·0	145·4	+ 3·9
1420	104·4	148·2	+6·7	2180	67·0	146·1	+ 4·6
1440	103·2	148·6	+7·1	2190	67·0	146·7	+ 5·2
1460	101·2	147·8	+6·3	2200	66·9	147·2	+ 5·7
1480	99·1	146·7	+5·2	2210	66·9	147·8	+ 6·3
1500	98·0	147·0	+5·5	2220	66·9	148·5	+ 7·0
1520	94·7	143·9	+2·4	2230	66·9	149·2	+ 7·7
1540	93·0	143·2	+1·7	2240	66·9	149·9	+ 8·4
1560	92·7	144·6	+3·1	2250	66·8	150·3	+ 8·8
1580	91·9	145·2	+3·7	2260	66·8	151·0	+ 9·5
1600	90·4	144·6	+3·1	2270	66·8	151·6	+10·1
1610	89·2	143·6	+2·1	2280	67·7	154·4	+12·9
1620	87·9	142·4	+0·9	2290	66·9	153·2	+11·7
1630	86·7	141·3	−0·2	2300	66·9	153·9	+12·4
1640	84·1	137·9	−3·6	2310	67·0	154·8	+13·3
1650	84·2	138·9	−2·6	2320	66·1	153·4	+11·9
1660	84·6	140·4	−1·1	2330	64·4	150·1	+ 8·6
1670	84·9	141·8	+0·3	2340	64·6	151·2	+ 9·7
1680	85·1	143·0	+1·5	2350	64·6	151·8	+10·3
1690	84·8	143·3	+1·8	2360	64·6	152·5	+11·0
1700	84·5	143·7	+2·2	2370	63·8	151·2	+ 9·7
1710	84·8	145·0	+3·5	2380	63·7	151·6	+10·1
1720	82·8	142·4	+0·9	2390	61·0	145·8	+ 4·3
1730	81·5	141·0	−0·5	2400	59·8	143·5	+ 2·0
1740	80·1	139·4	−2·1	2410	59·2	142·7	+ 1·2
1750	78·3	137·0	−4·5	2420	57·1	138·2	− 3·3
1760	78·3	137·8	−3·7	2430	57·1	138·8	− 2·7
1770	80·5	142·5	+1·0	2440	54·5	133·0	− 8·5
1780	79·7	141·9	+0·4	2450	52·8	129·4	−12·5
1790	79·2	141·8	+0·3	2460	52·2	128·4	−13·1
1800	78·8	141·8	+0·3	2470	52·2	128·9	−12·6
1810	74·7	135·2	−6·3	2480	52·3	129·7	−11·8
1820	74·9	136·3	−5·2	2490	52·3	130·2	−11·3
1830	74·7	136·7	−4·8	2500	52·3	130·8	−10·7
1840	74·7	137·4	−4·1	2510	52·4	131·5	−10·0
1850	74·7	138·2	−3·3	2520	52·4	132·0	− 9·5
1860	74·5	138·6	−2·9	2530	52·5	132·8	− 8·7
1870	72·3	135·2	−6·3	2540	52·6	133·6	− 7·9
1880	73·3	137·8	−3·7	2550	52·6	134·1	− 7·4
1890	74·5	140·8	−0·7	2560	52·7	134·9	− 6·6
1900	71·5	135·9	−5·6	2570	52·7	135·4	− 6·1
1910	71·6	136·8	−4·7	2580	53·4	137·8	− 3·7
1920	69·9	134·2	−7·3	2590	53·5	138·6	− 2·9
1930	69·5	134·1	−7·4	2600	53·6	139·4	− 2·1
1940	69·0	133·9	−7·6	2610	53·6	139·9	− 1·6
1950	69·4	135·3	−6·2	2620	53·7	140·7	− 0·8
1960	69·6	136·4	−5·1	2630	53·8	141·5	0·0
1970	69·2	136·3	5·2	2640	51·5	136·0	− 5·5
1980	68·4	135·4	−6·1	2650	52·1	138·1	− 3·4
1990	68·2	135·7	−5·8	2660	52·0	138·3	− 3·2
2000	68·3	136·6	−4·9	2670	52·0	138·8	− 2·7
2010	68·3	137·3	−4·2	2680	52·0	139·4	− 2·1
2020	68·4	138·2	−3·3	2690	52·0	139·9	− 1·6
2030	68·2	138·4	−3·1	2700	51·9	140·1	− 1·4
2040	68·5	139·7	−1·8	2710	51·9	140·6	− 0·9
2050	68·4	140·2	−1·3	2720	51·9	141·2	− 0·3
2060	67·7	139·5	−2·0	2730	51·9	141·7	+ 0·2
2070	67·8	140·3	−1·2	2740	51·9	142·2	+ 0·7
2080	68·0	141·4	−0·1	2750	51·9	142·7	+ 1·2
2090	68·2	142·5	+1·0	2760	51·9	143·2	+ 1·7
2100	67·9	142·6	+1·1	2770	52·5	145·4	+ 3·9
2110	67·8	143·1	+1·6	2780	52·5	146·0	+ 4·5

Mean value of k = 141·5 for velocities 1300 to 2780 feet per second.

I have recently calculated some ranges of elongated shot for low elevations, starting with a m.v. of 1900 f.s., allowing 6′ for "jump." The following are the results obtained:—

Elevation	1°	2°	3°	4°	
Experimental range...	1086	1811	2400	2917	yards
Calculated range ...	1049	1814	2392	2896	,,
Difference ...	−37	+3	−8	−21	,,

In the Final Report (pp. 43-45) will be found calculated ranges for comparison with range tables, both English and German, for upwards of 120 ranges fired with muzzle velocities below 800 f.s. Taking the best of the English comparisons where the m.v. was 751 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	35°	
Exp. range...	978	1788	2467	3000	3467	3813	4000	yds.
Calc. ,, ...	973	1780	2462	3027	3473	3804	4013	,,
Difference ...	−5	−8	−5	+27	+6	−9	+13	,,

The worst was for a m.v. of 628 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	35°	
Exp. range...	691	1236	1767	2231	2683	3017	3194	yds.
Calc. ,, ...	698	1290	1805	2242	2593	2858	3037	,,
Difference ...	+7	+54	+38	+11	−90	−159	−157	,,

The best German comparison was with a m.v. of 705·4 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	
Exp. range...	875	1598	2221	2729	3139	3452	yds.
Calc. ,, ...	867	1591	2214	2730	3143	3449	,,
Difference ...	−8	−7	−7	+1	+4	−3	,,

The worst was for a m.v. of 774·3 f.s.:—

Elevation	5°	10°	15°	20°	25°	30°	
Exp. range...	1020	1900	2659	3274	3745	4130	yds.
Calc. ,, ...	1028	1878	2590	3181	3641	3987	,,
Difference ...	+8	−22	−69	−93	−104	−143	,,

The calculations were all made for the English projectiles where $d^2 \div w$ = ·5616, while for the German projectiles $d^2 \div w$ = ·5785. If the latter value could have been conveniently used for the German ranges, &c., the calculated ranges would have been slightly reduced, which would generally have given a still better agreement between experiment and calculation.

Since the publication of my Final Report (1880) several pamphlets treating of the resistance of the air have been issued from the private printing press of M. Krupp. The main object seems to have been to persuade the world that the Krupp system entails a lower resistance to the shot than that encountered by the English system. The difference, if any, appears due to the more pointed form of the Essen projectile, and to the lower density of the air adopted. In general no sufficient explanation is given of the particulars of the experiments made. But in the paper (xxx.) some details have been furnished of experiments undertaken at Meppen (1881) to try whether the resistance of the air varied as the square of the velocity for velocities above 400 m.s. Supposing this to be the case, an expression was found for λ the coefficient of resistance in terms of the velocities of the shot at two points in its course, the distance between them, &c.

Six chronoscopes were distributed in pairs—one pair being placed at *A*, 30 metres from the gun; another pair at *B*, 130 metres from the gun; and the remaining pair at *C*, 500, 1000, &c., metres from the gun. The experiments were arranged in groups. We will examine group 3, formed of rounds 7, 8, 9, and 10. The mean velocity at *A* was stated to be 900·1 m.s.; at *B*, 853·2 m.s.; and at *C*, 438·1 m.s. Taking the range *A C*, the value of $\lambda 10^6$ was found 3·585; and the range *B C* gave 3·700; so that the mean of the two was 3·64. The mean value of $\lambda 10^6$ finally adopted was 3·66, differing very little from the above result.

But if we examine the matter more closely we find that the velocities for round 9, given by the two chronographs at *A* were 907·4 and 887·2 m.s., showing a difference of 20·2 m.s., or 66·3 f.s.; and for round 10 there was a difference in the measured velocities at *B* of 19·4 m.s., or 63·6 f.s.; while at *C* there was only *one* velocity measured for all four rounds, by one instrument; so that the determination of the value of λ in both the above cases was made to depend upon one solitary velocity, measured by an instrument manifestly unreliable. But at both *A* and *B* the velocity adopted was an average of the results of eight measured velocities. Consequently these velocities at *A* and *B* may be expected to give a trustworthy value of λ over range *A B*, if the experiment be of any importance. Substituting we find $\lambda 10^6 = 2·58$, something very different from its adopted value 3·66. So that, according to this group 3, the Newtonian law of resistance holds for velocities between 900 and 438 m.s., and for velocities between 853 and 438 m.s., but not for velocities between 900 and 853 m.s.! Group 2 is still more inconsistent.

Gen. Mayevski is also the author of an attempt to express the laws of the resistance of the air to elongated projectiles from extensive experiments said to have been made at Meppen in 1881. The projectiles were more pointed, and the standard density of the air adopted was less than those used in England. Capt. Ingalls, having reduced Gen. Mayevski's coefficients to English measures for convenience of comparison, remarks, "It will be seen that these coefficients are less than the corresponding coefficients derived from Bashforth's values of *K*, given above. This is undoubtedly due to the different forms of projectiles used in the two series of experiments, and particularly to the difference in the shapes of the heads" (p. 21). My values of *K* were derived from about 350 rounds, each of which in general furnished from 8 to 10 *consistent* records, and gave numerous values of *K* by the help of a single chronograph. And the values of *K* used in the above tables are the means of 40, 30, 20, 10, &c., independent determinations of *K* for each velocity. Beyond a doubt they express accurately the average results of the rounds fired.

Although the shooting of recent guns is said to have been improved, it is doubtful whether the coefficients of resistance will require any sensible reduction on that account for long ranges. For, as we have seen, however steady may be the initial motion of an elongated shot, the lateral action of the air must soon set up a gyratory motion of the shot, and therefore the axis of the shot must become oblique to the direction of motion. And we are told that a slight initial unsteadiness of the shot becomes corrected, so that it steadies down in its flight. This we might expect from the nature of the action of the air on an elongated projectile rotating about its axis, which tends to place the axis approximately in the direction of the motion of the shot. But, if it should be found necessary to reduce the coefficient of resistance, this, as I have said, can be effected by writing $K\sigma$ instead of K, where σ is less than 1. But inasmuch as we have to use $\frac{d^2}{w} \times K\sigma = \frac{d^2}{w}\sigma \times K$, we must first calculate the value of $\frac{d^2}{w}\sigma$, and then use the tabular numbers in the usual manner.

F. BASHFORTH

PLANTS CONSIDERED IN RELATION TO THEIR ENVIRONMENT

THAT great differences of constitution are to be found among plants is at once evident—differences affecting internal structure, external form, and habit of life. Those of structure and form at first seem likely to be correlated, and no doubt such relation to a large extent does obtain, but still it is not at all exact, differences of form occurring between plants whose internal structure closely agrees. The study of the environment of the particular plant enables us to see that this must be taken into account in tracing the changes that have made it what it is, each plant having a power of adaptation to circumstances which determines the form which it assumes, which modifies, though with extreme slowness, its internal structure, and which leads in course of time to the recognition of new species.

Looking at plants from this point of view, we notice at once great differences between those which flourish in water and those whose home is on land. These, again, show diversities between those whose habit is terrestrial and those which are epiphytic, while others are noticeable whose habit of life is more or less completely parasitic, and whose constitution and structure are much modified in consequence.

A typical land plant will be seen to consist of a stem, branching continually, bearing a variable but usually very large number of leaves, and continuous below with a root or system of roots embedded in the soil. The stem will be characterised by a great development of wood, rigidity being thus secured. The leaves will be noticeable especially for their great extent of surface in relation to their bulk, and will show, generally on their under surfaces, though very frequently on both, a large number of stomata. The roots will be woody, like the stem, and towards their ultimate terminations will be found to bear a varying number of delicate root-hairs, by means of which they are enabled to discharge their special function of absorption of water.

This plan of construction is considerably deviated from by plants whose habit is aquatic. The stiffness so essential to a land plant, which has to resist storms of wind, is not at all essential to a water one, which has rather to adapt itself to varying currents of water. More flexibility, and that of a rather different kind, is needed by the stem. We find, consequently, that the rigidity of an aquatic plant is mainly arrived at by the development of turgid parenchymatous tissue containing typically large intercellular spaces, while the woody tissue largely disappears. The intercellular spaces in most cases form a very elaborate system, as may be seen on examining the petioles of the large white water-lily (*Nymphæa alba*), the stem of the common mare's-tail (Hippuris), or the whole plant of different species of Potamogeton. The number of the fibro-vascular bundles is much less than would be the case in the stem of a land plant of similar dimensions, but the most noticeable difference is the relatively much smaller amount of woody tissue in each bundle. This difference of internal constitution may be connected also with a functional difference associated with the environment. The woody tissue of a plant is concerned with the transmission of water upwards from the roots to the leaves. In the case of an aquatic plant this is not needed to anything like the extent to which it is in an ordinary tree, and hence a further reason for the disappearance of woody elements. Nor is it only the stem which has been affected by the habitat. The character of the root will be found to vary. This is best seen in noticing the effect of allowing the root of an ordinary land plant to come into contact with a quantity of water. By its constitution it is fitted to absorb only the hygroscopic water surrounding particles of soil. The first effect of the contact with excess of water is to cause the root to perish; but after a time new roots are developed which can utilise the moisture they now are in contact with, and which in turn are unable to avail themselves of the hygroscopic water which before was necessary. Both kinds of roots may be seen sometimes on plants which have been growing close to pipe-drains, some having penetrated the drain, and so come into contact with water in quantity; others remaining unchanged, and utilising only the water of the soil. Such differences may be noticed also in the case of hyacinths, grown some by water culture in glasses, others in ordinary earth. The former roots are larger and more succulent than the latter. A difference also may be seen in the development of the root-hairs, though a very definite statement about this can hardly be made. Still, in allied species, and often in individuals of the same species, the hairiness of the roots increases with increasing sunlight, dryness, and airiness of the spot in which the plants are growing.

The leaves also undergo much structural modification. Many plants have leaves which are totally submerged, and these are able to resist the action of the water, which would soon destroy ordinary leaves, whose constitution fits them to live only in air. Some amphibious plants show this peculiarity well. They grow generally in marshy places, or on the banks of streams, by which they are often submerged. Such a plant, having its land form, possesses leaves which die on being submerged, but later it puts out other leaves which are not injured. In *Lycopus europæus* and in *Lythrum Salicaria* there is also a histological difference between the stems grown in water and those grown in air. Two layers of cells containing no chlorophyll are developed in the watery specimens deep down in the cortical parenchyma The outer layers of tissue perish, and these new cells then serve to protect the tissues within. In the leaves of water plants also, other peculiarities are noticeable. Generally chlorophyll is developed in the epidermis, a fact which is perhaps connected with the slight amount of evaporation taking place The position of the stomata and their relative number in different cases is also closely connected with their habit of life. This may be well seen in Marsilea, whose leaves, though generally raised above the surface of the water, are sometimes to be found floating on the surface. The aërial leaves have stomata on both upper and under surfaces, but the swimming ones have them only on the upper surface, and have then three times the number that the same surface of the aërial leaf possesses. It is easy to show that the change is the result of the change in the environment, for if a piece of the plant, possessing quite young leaves, be submerged and kept under the surface, the young leaves will develop into swimming-leaves, and not aërial ones. In other water plants with large floating leaves the same disposition of stomata may be seen. Generally on sub-aërial leaves it is the lower surface which shows them in far the larger quantity. The environment of the plants then seems to have a great influence on their distribution, that arrangement being followed which is best suited to keep the stomata dry.

A curious adaptation of structure to environment is seen in the roots of the epiphytic orchids and aroids. These are aërial in habit, hanging freely downwards. Not coming into contact with water in the same way as either aquatic or terrestrial plants, they have no root-hairs. There is a development of tissue met with in them which enables them to absorb and avail themselves of the moisture in the atmosphere. Instead of the usual single-layered epidermis, they are covered by a many-layered velamen made up of numerous cells fitting closely together, of the description known as tracheïdes. The usual cuticle or secretion from the outer walls of the epidermis, which is always very little developed in roots, is here altogether absent; the membranes of the cells are usually colourless, and the cells themselves contain air. This layer absorbs water quickly, supplying the plant with moisture.

The influence of the environment on the forms of leaves, as well as on their structure, can be well seen also in aquatic plants. The swimming-leaves show certain general resemblances, their form being more or less rounded, and not as a rule lobed or cut; they are, too, usually of fair dimensions. In the case of submerged leaves we find differences which are connected with the conditions noticeable in the water. Thus, in a rapid stream they are generally long and very much divided, while in stagnant water this is not the case. Three species of the genus Ranunculus especially exhibit a gradation in this respect. *R. divaricatus* is a denizen of stagnant water; *R. aquatilis* is found in slowly-flowing streams; *R. fluitans* in rapid ones. The divisions of the leaf are longest in the last case and shortest in the first, the second being intermediate. *R. aquatilis* is an amphibious form, and shows well how environment decides the character of the adult plant. When growing in a pool it has its leaves in fairly long divisions, the lobes being rounded and the internodes long. If the pool should dry up, it changes gradually, the new leaves being less divided and the divisions becoming flattened, while the nodes are nearer together. The epidermis, which in the water form had almost square walls, now becomes serpentine. Growing so, it produces in due time its flowers and seeds, and these latter reproduce the land form. If the pool again becomes filled with water, a reversion speedily takes place, and again the characteristics of the water form are seen. The two are, in fact, easily converted from the one into the other.

Not only is the correspondence between environment, form, and structure seen in the species of Ranunculus already alluded to, but the whole genus can be divided into two sections, those of terrestrial and those of aquatic habit, so nearly allied to each other in all points of so-called systematic importance that they are now included together under the common name Ranunculus, and yet extremely dissimilar in form and structure of the vegetative parts. The same difference in amount of woody tissue as has been alluded to above can be seen most strikingly by comparison of sections of the stem of *R. repens* with those of the stem of *R. fluitans*.

Turning now from aquatic plants to those which, though alike terrestrial, are yet situated amid very different surroundings, the effect of the environment can easily be traced. Take, first, the plants which inhabit regions in which habitually the air contains very little moisture. These may be affected in several different ways—the most conspicuous modification perhaps being the different forms of succulent plants, such as *Mesembryanthemum*. In these the leaves have lost the usual ratio between surface and bulk; they are now thick and fleshy, their internal parenchyma being very succulent or pulpy; their outer layers leathery, with comparatively few stomata, and a great reduction of the system of intercellular spaces typically found in the leaf. Their environment has led to such a structure as will enable them to make the most of the limited supply of moisture, great facilities being seen for storing it, and precautions taken against its escape. Similar adaptations, but affecting the stems and not the leaves, are found, *e.g.*, in the branching, fleshy Opuntias, while we have also large, thick, fleshy leaves in the aloes and agaves of such regions. The genus Euphorbia has some strange representatives here. There are several hundred species of this genus, inhabiting all parts of the world, and all characterised by the peculiar structure of the flower familiar to us in the common spurge of our gardens. The great majority of the species are annual or perennial herbs, with slender unarmed stems bearing great numbers of scattered, sessile, simple leaves. The comparatively few members of the genus which inhabit the regions of little moisture have become so extremely modified in their vegetative parts as to closely resemble cactuses. *E. canariensis* especially has taken on this peculiar habit, developing enormously its stem and branches, the former becoming in some cases 20 feet high, and ceasing to produce leaves, while the branches are plentifully supplied with prickles.

A curious modification in the cells of the leaf is seen sometimes in some species of Oxalis. In plants grown in well-shaded spots the cells of the pallisade parenchyma are not so much elongated as in those exposed to more light, but are more conical. In the beech too a similar difference is noted. In the sun the leaf is smaller and thicker, and has several layers of pallisade parenchyma, while in the shade it is large, but thin, and the pallisade layer is single.

Looking still at terrestrial plants, the general character of the vegetation in different regions illustrates well the general correspondence between environment and structure. In the tropics we find vegetation luxuriant, huge trees with evergreen leaves, masses of interlacing climbers, a great tendency of the smaller plants to become shrubby, even some annuals simulating the bushes of temperate regions; the presence of palms, tree-ferns, &c. Higher in latitude these disappear, bushes are more numerous; the trees become less luxuriant and more compact, the leaves smaller and more rigid; annuals are found in larger proportion, while mosses and lichens make their appearance. Still higher, where the influence of winter begins to be felt, the trees have as a rule deciduous leaves, which do not cover them for more than half the year. Where the leaves remain evergreen, as in the Coniferæ, they are specially constructed to resist cold, being strongly cuticularised and altered in form so that the ratio of surface to bulk is much lessened. In the pines especially they are much elongated, becoming almost needle-like in shape. Their structure is adapted especially to check loss of water by evaporation, and to protect the delicate parenchyma of the interior from the access of the cold.

Various modifications of structure accompany also a parasitic habit of life. Here the effect of the environment must be taken to include all the various interferences with the normal habits of plants brought about by the changes in the mode of nutrition which the parasite now pursues. The modifications will be seen to be greater the more complete the parasitism. We may consider what are perhaps the most striking cases, those found among flowering plants. Of these we have certain Scrophulariaceæ which show but little modification. They take only part of their nourishment from their hosts, being furnished with means of living exactly like other plants. The dependence of the different species of Orobanche on the host is more complete. The outward form of the plant is there; the long stem, bearing small leaves. In accordance with the mode of nutrition, all the food being absorbed from the host, the power of absorbing food or obtaining energy from without the latter has gone; the leaves contain no chlorophyll, and are consequently brown and shrivelled. In Cuscuta the process of degradation has gone still further, even the leaves having disappeared. The degradation does not affect merely the vegetative structure, but the reproductive organs also suffer, as may be seen in the common mistletoe. This change, however, seems only incidentally to be connected with the environment, being rather the result of the disturbance of the constitutional equilibrium brought about by the changes in nutrition.

A comparison of lower forms of parasitic habit with others which, though about as high in the scale, do not depend on a host for support, reveals similar degradation brought about by the nature of the mode of life. Their power of independent growth has much decreased, their cells often appear to contain no nuclei, or these are made out with difficulty; they have no chlorophyll, nor any of the other colouring matters which are present in the non-parasitic forms.

Some curious modifications of structure are associated also with different climbing plants. These are not of so general a nature as those already alluded to, being noticeable only on particular species. In *Ampelopsis hederacea*, and in *A. Veitchii* the curved tips of the tendrils, after touching a surface, form adhesive disks, which secrete and pour out a resinous cement which attaches the tendril to the surface. *Bignonia capreolata* has a similar but more elaborate development, while *Ficus repens*, which climbs like the ivy by rootlets, exudes similar material from its rootlets, this being somewhat of the nature of caoutchouc.

Not only the vegetative parts of plants thus exhibit modifications of structure according to the nature of their environment, but the same thing can be seen especially with regard to the structure of the reproductive organs. The ways in which these are adapted to different modes of fertilisation would however pass far beyond the limits of this article.

NOTES

PROF. MELSENS, the distinguished chemist, has died at Brussels, at the age of seventy-two.

BY the death of the Rev. W. W. Newbould, F.L.S., which took place on April 16, at Kew, at the age of sixty-seven, a figure has passed away very familiar to the frequenters of the meetings and library of the Linnean Society, the British Museum herbarium and reading-room, and the herbarium at Kew. At the time of his student-days at Cambridge, where he was a pupil of Prof. Henslow, Mr. Newbould acquired a love of botany, which became the recreation, and latterly the pursuit, of his life. His interest was, however, confined to a study of our native British plants, the limitation of the species, and especially their geographical distribution. Several of our local county floras owe much to his co-operation; and of some particular groups of plants he had a very exact knowledge. But his speciality was an intimate acquaintance with the botanical bibliography of this country; in his knowledge especially of the older literature he was almost unrivalled.

MANY will regret to learn of the death of Thomas Edwards, the Banff naturalist, so well known through his Life by Mr. Samuel Smiles. Edwards was born on Christmas Day, 1814, at Gosport, Portsmouth, where his father, a private in the Fifeshire Militia, was stationed after returning from the Peninsular War. Early in life Thomas Edwards showed indications of a great love of animals, insects, and creatures of every description. He made extensive excursions in search of specimens, and many amusing anecdotes are told to illustrate his extreme fondness for even the most repulsive subjects in the animal creation. At eleven he was apprenticed to a shoemaker, and at the age of eighteen he had undergone many severe trials. He joined the Militia, but his love of insects proved fatal to his military ambition. In his twentieth year Edwards went to work as a shoemaker at Banff, and there he pursued so successfully his researches in natural history that he added a great deal to his scientific store of knowledge. For fifteen years he carried on the most of his researches by night, and he had many narrow escapes by reason of the eagerness with which he pursued his object. He completed, however, a splendid collection, and in 1846 exhibited it in Aberdeen. The exhibition was a failure, and he had to sell the collection for 20*l.* to defray the expenses. He then set to work to form another collection, and was mo t successful. His researches added greatly to the knowledge of natural history, as he embodied his new discoveries in papers written to scientific magazines. In 1866 Edwards was elected a member of several scientific societies. Latterly he had acted as Curator of Banff Museum. After the publication of his biography by Smiles, Edwards's genius was publicly recognised by a presentation of 333*l.* made to him in Aberdeen, and he was awarded by the Queen a pension of 50*l.* a year.

A CORRESPONDENT writes:—Under the name of the "phonophore" a remarkable telephonic invention is about to be introduced to public notice by Mr. Langdon Davies. The name is given to a contrivance which, while absolutely a non-conductor of continuous electric currents, still allows of the passage or transmission of rapidly-alternating currents such as correspond to sounds in vocal and harmonic telephony. The "phonophore" itself may be regarded as at once a condenser and an induction coil. It consists essentially of two insulated wires laid side by side, twisted together and wound up upon a bobbin, one end of each wire being completely insulated. Regarded as a condenser, its capacity is very feeble indeed. Regarded as an induction coil, it will be seen that neither the primary nor the secondary forms a closed circuit. Yet it transmits telephonic speech perfectly. It follows that Mr. Langdon Davies has solved the problem of telephoning on an open circuit. But the real object of the invention is to enable telephonic messages, including both vocal and harmonic under that name, to be transmitted through the ordinary telegraph-wires without interference with or from the telegraphic messages that are simultaneously passing through the wires. For many months Mr. Langdon Davies has been at work experimenting upon the lines of telegraph-wire running across the county of Kent. He has devised a whole series of new telephonic apparatus in which not only the induction-coils of the transmitters, but also the bobbins of the receivers, are replaced by open-circuit phonophore coils. Apart from its purely technical value, the new instrument presents several points of great scientific interest, and opens up sundry new problems to the mathematical physicist.

A NEW method of reading small angular deflections, as, for example, those of galvanometers, has been devised by Dr. D'Arsonval. It may be briefly described as the inverse of Poggendorff's (subjective) method. Usually the objective of the observing telescope forms at the conjugate focus a diminished image of the object—the scale as reflected in the mirror. Dr. D'Arsonval places the scale—a small one, reduced by photography, giving tenths and twentieths of a millimetre—at this conjugate focus, and obtains a magnified image of it reflected in the mirror, and situated above the objective. This enlarged image, which is enormously displaced for small angular movements of the mirror, is again observed by an eyepiece bearing the usual cross-wires.

THE annual meeting of the Iron and Steel Institute has been arranged to take place in London on the 12th, 13th, and 14th of May next. On the first day of the meeting the President (Dr. Percy, F.R.S.) will deliver an opening address. The Council have decided to present the Bessemer Gold Medal to Mr. Edward Williams, of Middlesbrough, who was for many years connected with the Dowlais Company, and Bolckow, Vaughan, and Company, in recognition of his services to the Institute and to the iron trade generally. The programme embraces a list of fifteen papers, four of which are adjourned from the meeting held in Glasgow last autumn, while eleven are entirely new papers. The subjects dealt with include the manufacture of tin plates (which is still, in spite of recent efforts of the Germans and Americans to secure a portion of the trade, an almost exclusively English industry); American blast-furnace practice; the tenacity of steel wire; the cost of blow-holes in open-hearth steel, by which the strength and reliability of that metal is affected; a neutral lining for metallurgical furnaces; the composition of cast iron; the use of wrought-iron conduit pipes; the manufacture of chrome steel; the endurance of steel rails; the microscopical structure of steel; and certain descriptions of Indian castings.

THE Institution of Mechanical Engineers will hold its next general meeting on Thursday, May 6, at 7.30 p.m., and Friday, May 7, at 3 p.m., at the Institution of Civil Engineers, 25, Great George Street, Westminster. The papers to be read are: "On the Distribution of the Wheel Load in Cycles," by Mr. J. Alfred Griffiths, of Coventry; "On the Raising of the Wrecked Steamship *Peer of the Realm*," by Mr. Thomas W. Wailes, of Cardiff; "On Refrigerating and Ice-Making Machinery and Appliances," by Mr. T. B. Lightfoot, of London; "Notes on the Pumping-Engines at the Lincoln Water-Works," by Mr. Henry Teague, of Lincoln.

MR. CUTHBERT E. PEEK'S Second Report of the Meteorological Observatory he established at Rousdon, Devon, in the end of 1883, has reached us, and it shows in several respects an improvement on the First Report. The weather notes of the months, while retaining their popular character, are now fuller and more precise, and form, so far as can be expected from the records of a single station, a very serviceable account of the weather of the year. A comparison of the weather forecasts of the Meteorological Office with the actual weather experienced at Rousdon continues to form part of the regular work, with the result that for 1885 the reliable forecasts for this part of England were 11 per cent. above that of 1884. Some interesting observations are made regarding sea-fogs and their extension inland, for observing which the Rousdon Observatory is well situated. A useful table is added to the Report in which the months are grouped respectively in order of frequency of sea-fogs, of mean wind velocity, of duration of bright sunshine, of rainfall, and of temperature; and we are glad to see that the mean temperatures of the months are included in the Report. We still, however, desiderate the monthly means for atmospheric pressure and humidity, and certain other details, which, as they are indispensable to such publications, Mr. Peek will, no doubt, include in future issues of his reports.

THOSE interested in the Daily Weather Reports of the Meteorological Office will have noticed with satisfaction the addition, since April 7, of a paragraph headed "Continental Information," which details the general features of the weather over the Continent on the previous day, taken from the data of the Daily Continental Weather Reports. With this greatly extended field of observation, not only is the weather of Europe generally brought more or less vividly before us, but a much clearer explanation is afforded of the more important weather changes occurring in the British Islands than can be given by weather maps covering a more restricted area. It is evident that much assistance would be rendered in framing forecasts of weather if daily telegrams were received from additional Continental stations. The immense importance of this extension will be seen by a reference to the recent anticyclonic areas of high pressure over Russia, often extending westwards through Scandinavia to the north of the British Islands, in connection with the low pressures at the time over southern and south-western Europe, as the immediate cause of the past hard winter (see NATURE, vol. xxxiii. pp. 447-48). Good results may fairly be expected to follow, as the area embraced by the stations increases in extent and in height through the atmosphere.

A CORRESPONDENT points out that the meteorological station at Sonnenblick, near Salzburg, 10,170 feet high, is not the highest in the world, that on Pike's Peak, Colorado, U.S., being 14,134 feet high.

THE various elevated meteorological stations of Europe, with their respective heights in metres, are thus given by Dr. Breitenlohner, the Director of the Observatory at Sonnenblick, near Salzburg, in an article in the last number of the *Mittheilungen* of the Vienna Geographical Society:—Italy—Monte Cimone, Apennines, 2162; Etna, Sicily, 2900. France—Puy-de-Dôme, Auvergne, 1463; Pic de l'Aignal, Cevennes, 1567; Mont Ventoux, Cottian Alps, 1960; Pic du Midi, Central Pyrenees,

2877. Switzerland—Säntis, Appenzell, 2500. Great Britain—Ben Nevis, 1418. Germany—Brocken, Harz, 1141; Wendelstein, South Bavaria, 1860. Austria—Schafberg, near Ischl, 1776; Hoch-Obir, Carinthia, 2047; Sonnenblick, Salzburg, 3103. These heights are taken from the sea-level.

FOR the first time the Government of the Straits Settlements has published in the official *Gazette* a separate meteorological report on the result of observations taken in the three settlements—Singapore, Malacca, and Penang—comprising atmospheric pressure, temperature, wind, rainfall, &c. The statistics, which are edited by Dr. Rowell, embrace the year 1885. Carefully compiled tables of observations and four charts are attached to the report.

AT a recent meeting of the Russian Archæological Society, Prince Putiatin reported his important discovery near the Bologne railway station (half way from St. Petersburg to Moscow) of an image of the constellation of Ursa Major engraved on a grindstone of the Stone period. A similar discovery, as is known, had already been made near Weimar in Germany.

THE sixteenth annual report of the Wellington College Natural Science Society is satisfactory as showing that the society is pursuing its useful work with much success. A considerable number of lectures on various scientific topics were delivered during the session, one of them being by Prof. Flower, and the usual phenological and meteorological reports are added. The value of such societies as these in connection with our public schools is obvious, and it is only to be wished that the list of school natural history associations were a much longer one. At present, we believe, there are only nine in all—Wellington, Winchester, Cheltenham, Marlborough, Clifton, Rugby, Dulwich, Haileybury, and King Edward's, Birmingham. Neither Eton nor Harrow, it will be noticed, is on the list, although both are favourably situated for the purpose.

A CORRESPONDENT at Gorebridge writes to the *Scotsman*:—On Thursday week (April 8), at twenty minutes past twelve, a slight shock of earthquake was felt in this locality. The low rumbling and vibration were felt by your correspondent quite plainly, though at first I did not put it down to its real cause. Afterwards I found that the miners employed in Lord Lothian's Newbattle pits, about a mile to the westward, had been alarmed by loud explosions and vibration of the strata in which they were employed. In East Bryans pit, a mile further to the north-east, the miners had a like experience, being also of the belief that an explosion had occurred in the workings. In the villages of Cowdengrange and Newtongrange the shock was felt most distinctly, houses and furniture appearing to oscillate, and the crockery in some instances falling from the shelves. The phenomenon lasted for about five seconds, travelling from east to west, but appears to have been confined to the low range known as the Roman Camp. About half-past twelve on Sunday morning a shock of earthquake was distinctly felt in Comrie and neighbourhood, as well as in St. Fillans district. Several of the inhabitants state that they were awakened by the peculiar tremor, and that there was a dull heavy sound at the time of the shock, resembling distant thunder. The vibration apparently passed from the north-west towards the south or south-east.

THE last number of Prof. Caporali's *Nuova Scienza*, which continues to attract general attention on the Continent, is of a somewhat iconoclastic character. After dealing with the inherent difficulties and contradictions of Prof. Sergi's materialistic doctrines, it proceeds to attack with its customary vigour and learning the modern school of metaphysicians, who study the mental and outward phenomena of nature from the subjective instead of the objective stand-point. Kant himself is not spared, and it is argued that, were his views accepted regarding the negative character of the concept of space, all progress in positive science would be arrested. No induction could be made from the known to the unknown, because nothing would ever be known with certainty, not even the very ground on which we stand. The followers of these idealistic theories are compared to mariners navigating a shoreless ocean, and ingulfed at last in a sea of phenomenalism and pure scepticism. Crude materialism and idealism being thus both set aside, Prof. Caporali returns to his own theory of the universe, which aims at a complete reconciliation of the psychic and mechanical views of material and biological evolution from the atom to the last outcome in the human intellect.

THE French Minister of Commerce has decided, subject to the approval of scientific men and specialists, to erect, either at the entrance, or at some other part of the Paris Exhibition, the gigantic metallic tower invented by M. Eiffel, the mechanical engineer. It will be 300 metres in height, and entirely constructed of iron. It will rest on five pillars, forming four immense arcades, lofty enough to exceed in height the towers of Notre Dame. On the summit of the tower will be erected an electric light-house, and a terrace to which visitors will be admitted. The tower is expected not only to be an extraordinary source of attraction to the building, but to render important services to science. It is suggested that meteorological and astronomical observations will be made at the summit under entirely novel conditions. An electric signal, placed on the summit of the tower, may be seen in clear weather at Dijon—a fact which will give the erection great importance in connection with military signalling and national defence.

AN interesting account of the latest information concerning the former bed of the Amu-Daria River was recently given by Baron Kaulbars before the Russian Geographical Society. He ascribes the alteration of the course of the river between Kilik and the Khiva oasis principally to the terrace-like character of the locality along which it runs; and, secondly, to the softness of the strata of the bed at the point where the river leaves the mountains. The strata are washed off, and their remains precipitated on a slightly inclined slope of the Chardjui oasis, producing periodical inundations. Consequently, reeds are growing, and lakes are formed along the bed of the river as the course of the water filtering through the reeds becomes slower and slower. Finally, the lakes, increasing in size and number, reach the edge of the terrace, overflow it, and open a new course for the river along another slope.

WITH reference to a communication which recently appeared in NATURE respecting a Fishery Board for England, and the remark that there is no Fishery Board in Norway, a correspondent writes that, though there is no Fishery Board in Norway, there is a General Inspector of Fisheries, Prof. A. Landmark, and that the Government have just appointed a Board consisting of three members, who shall be practical men, knowing the best markets, &c., which would be of benefit to the Norwegian fisheries. We ought to add that the reports and suggestions recently issued by the Norwegian Inspector of Fisheries contain many valuable hints respecting the salmon- and trout-fishing in Norway, and the Inspector seems fully alive to the necessity of enacting as stringent fishery laws for Norway as those in force in this country.

IN the year 1882–83 the Norwegian Inspector of Fisheries imported at the public expense a parcel of ova of the American trout (*Salmo fontinalis*), with a view to introduce this fish into Norwegian waters, and the result has been so satisfactory that last autumn one of the hatching establishments near Christiania had some 30,000 young fish to offer for sale, which were then about two and a half years old. The result appears to have been welcomed with great satisfaction in Norway, as it proves that this fish is capable of increasing in almost stagnant waters, where the Norwegian trout cannot exist, though its size is smaller. As an example of the success of this experiment it may be mentioned that the Norwegian Inspector of Fisheries, Prof. A. Landmark of Christiania, offers these ova at ten shillings per thousand.

THE additions to the Zoological Society's Gardens during the past week include a Garnett's Galago (*Galago garnetti*) from West Africa, presented by the Rev. W. C. Porter; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. James B. Bevington; a Common Badger (*Meles taxus*), British, presented by Mr. E. Gully; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. Bateson-de-Yarburgh; six Barbary Turtle Doves (*Turtur risorius*) from Africa, presented by Mr. Richard Seyd, F.Z.S.; a Robben Island Snake (*Coronella phocarum*) from Robben Island, South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Pale-headed Tree Boa (*Epicrates angulifer*) from Cuba, presented by Miss M. Hunt; an Ogilby's Rat Kangaroo (*Hypsiprymnus ogilbyi*), a Roseate Cockatoo (*Cacatua moluccensis*) from Australia, three Poë Honey-eaters (*Prosthemadera novæ-zealandiæ*), a Huia Bird (*Heterolocha gouldi*), five —— Gannets (*Sula* ——) from New Zealand, deposited; two Collared Fruit Bats (*Cynonycteris collaris*), born in the Gardens.

GEOGRAPHICAL NOTES

THE last number of the *China Review* contains the first part of an article by Mr. G. Taylor on that interesting and little-known subject, the aborigines of Formosa. The writer has lived in the extreme south of the island, in daily communication with the people there for four years, and has therefore more experience of the southern type than all previous writers put together. He divides the Formosans south of Takow—that is, the southern peninsula—into four parts: the Paiwans, inhabiting the extreme south; the Pepohuans, or half-castes, of the plains; the Tipuns, inhabiting the great plain inland from Pilam; and the Ameirs, who have scattered themselves in small villages along the east coast down to South Cape. Of these, he can speak of the Paiwans from intimate personal observation; the Ameirs he is also acquainted with; but in the case of the others he has gathered his information from straggling members who have been found domiciled among the Paiwans. The present instalment is devoted wholly to the latter, *Paiwan* being the generic name of all the savage tribes on the south coast, and on the west up to Tang-Kang. These, at least, show no traces of the Negrito mixture which is supposed to exist among certain Formosan tribes. They are of a bright copper complexion, with black, straight hair, of a coarse texture. Mr. Taylor describes their physical features, their traditions of their origin, their arts (which are disappearing through contact with the Chinese), their superstitions and customs. They have a dim belief in the transmigration of souls, probably derived from Buddhist sources, and think that some souls are, as a mild punishment for minor misdeeds, condemned to pass into certain animals, where they remain for a time. The Subongs, a northern tribe of the Paiwans, are still almost absolutely independent, and still preserve the practice of head-hunting. They have known and wrought iron as far back as their traditions extend; they wear a ring in the lobe of the ear inserted in a hole formed by gradual expansion, and these ear-rings are the true mark of aboriginal descent, half-castes and Chinese not being allowed to wear them. One tribe of Paiwans, the Koaluts, has the custom of killing off infants when the tribe increases beyond a certain number, the saying being that whenever their tribe increases beyond the traditional limit they are certain to be visited by a pestilence. The paper is very interesting, and the whole promises to be a work of much ethnological value.

TELEGRAMS from Cairo and Aden announce the massacre by the Emir of Harrar, in the Somali country, of the members of an Expedition sent out by the Geographical Society of Milan. The Expedition was under the charge of Count Porro, and, besides the leader, the other victims were the Count Montiglio, Prof. Sicata, Dr. Gethardi, Signori Romagnoli, Janin, Bianchi, and two servants. They were set upon by the Emir with 200 soldiers between Geldessa and Arton.

ACCORDING to information received in Paris, M. Barral and his wife, who had set out from Obock to explore a great part of Abyssinia and to establish commercial relations in the country, were murdered by the Danakils on the frontiers of Shoa.

THE *Izvestia* of the East Siberian branch of the Russian Geographical Society are appearing now in a new shape, similar to that of the *Izvestia* of the St. Petersburg Geographical Society. The last issued fascicule contains a short account of the geological excursions undertaken by the Society during the years 1883 and 1884. M. Dubroff continues the report of his journey to Mongolia, in which he gives much valuable topographical information concerning the valleys of the rivers Baikoy, Eder, Delgir-Moria, and Selenga, as also some ethnographical notes. M. Cherski contributes a paper containing the geological observations he has made during a journey from Irkutsk to the river Nijnia Tunguska. A good deal of attention was paid by the author to the geological features of the valley of the Middle Lena (from Kachug to Kirensk), which had been visited formerly by many explorers (Zlobin, Erman, Stchukin, Meglicki, Middendorff, Krapotkin, and Chekanefski), but never made a subject of special investigation. M. Cherski found there in the red sandstone of the valley some valuable exterior casts of shells similar to those of *Orthis*, but unfortunately the specimens were subsequently spoiled on their way to St. Petersburg, and therefore the question concerning the origin of the red sandstone still remains open. Finally he describes the Mammalia which now inhabit the valley of Nijnia Tunguska, as also those which inhabited it during the Palæolithic period, such as *Bos priscus*, *Bos primigenius*, *Rhinoceros tichorrhinus*, *Elephas primigenius*, *Cervus canadensis*, and *Castor fiber*, the last three having only disappeared in recent time.

DR. KONRAD KELLER, of the Zürich University, is about to start on a scientific exploring expedition to Madagascar. The Swiss Ministers of Agriculture, Commerce, and Internal Affairs, the Mercantile Society of Zürich, and the East Swiss Commercial Geographical Society will jointly bear the cost of the expedition.

OUR ASTRONOMICAL COLUMN

THE PARALLAX OF ψ^5 AURIGÆ.—Herr W. Schur, of Strassbourg, has published in the *Astronomische Nachrichten*, No. 2723, a determination of the parallax of this double-star, deduced from a series of measures of position-angles and distances of the components made by him with the 6-inch refractor of the Strassbourg Observatory, on thirty evenings between January 14, 1883, and January 29, 1885. Transforming the observed position-angles and distances into $\Delta\alpha \cos \delta$ and $\Delta\delta$, and attempting, first, to determine corrections to the assumed proper motions of the brighter star (taken from Auwer's Fundamental-Catalog.), Herr Schur finds—

Correction to assumed proper motion in $\Delta\alpha \cos \delta = +0''\cdot075 \pm 0''\cdot027$, $\pi = +0''\cdot161 \pm 0''\cdot036$.

Correction to assumed proper motion in $\Delta\delta = +0''\cdot013 \pm 0''\cdot021$, $\pi = -0''\cdot011 \pm 0''\cdot096$.

Combining the two values of the parallax resulting from the differences of R.A. and declination respectively, there results $\pi = +0''\cdot140 \pm 0''\cdot034$. An examination of the measures of this double-star, made from Herschel's time on, shows that there is no perceptible orbital motion in the system, but also shows that this comparatively large correction to the assumed proper motion in $\Delta\alpha \cos \delta$ is inadmissible. Putting, therefore, these corrections to the assumed proper motions $= 0$ in his equations, the circumstances being unfavourable for their determination, Herr Schur finds—

From differences of R.A., $\pi = +0''\cdot126 \pm 0''\cdot036$
,, Decl., $\pi = -0''\cdot009 \pm 0''\cdot094$

and, finally, $\pi = +0''\cdot111 \pm 0''\cdot034$. It is to be remarked that this value refers to the fainter star of the pair (mag. 9·0, that of the other component being 5·3 according to Struve's estimate), in the observations the place of this star having been referred to that of the brighter one. Herr Schur thinks he is justified in asserting that the parallax of this star is at least $0''\cdot1$,—a remarkable result considering the fixity of the object.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 MAY 2-8

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 2

Sun rises, 4h. 32m.; souths, 11h. 56m. 50·4s.; sets, 19h. 22m.; decl. on meridian, 15° 26′ N.: Sidereal Time at Sunset, 10h. 4m.

Moon (New on May 4) rises, 4h. 10m.; souths, 10h. 42m.; sets, 17h. 25m.; decl. on meridian, 5° 29′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 0	10 23	16 46	3 50 N.
Venus	3 13	9 5	14 57	2 18 S.
Mars	12 59	19 57	2 55*	10 39 N.
Jupiter	14 49	21 7	3 25*	2 43 N.
Saturn	7 26	15 38	23 50	22 51 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

May	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
6	111 Tauri	5½	20 12	21 3	114 324
6	117 Tauri	6	21 42	22 21	88 342

Saturn, May 2.—Outer major axis of outer ring = 39″·1; outer minor axis of outer ring = 17″·4; southern surface visible.

May	h.	
2	1	Mercury in conjunction with and 0° 6′ south of the Moon.
7	1	Mercury at greatest elongation from the Sun, 26° west.

Positions of the Comet Barnard (for Berlin Midnight)

May	R.A. h. m. s.	Decl. ° ′	Log. Δ	Brightness
2	1 38 8	40 28 N.	9·956	118
4	1 39 14	40 6	9·924	136
6	1 41 34	39 23	9·889	155

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Monocerotis	7 25·4	9 32 S.	May 6,	0 0	*M*
R Crateris	10 55·0	17 43 S.	,, 3,	0 0	*M*
δ Libræ	14 54·9	8 4 S.	,, 2,	3 0	*m*
U Coronæ	15 13·6	32 4 N.	,, 6,	23 35	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 5,	3 4	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	May 5,	2 20	*m*
			,, 8,	0 0	*M*
U Sagittarii	18 25·2	19 12 S.	,, 2,	21 40	*m*
			,, 5,	21 35	*M*
β Lyræ	18 45·9	33 14 N.	,, 3,	2 25	*m*
η Aquilæ	19 46·7	0 7 N.	,, 7,	0 0	*M*

M signifies maximum; *m* minimum.

Meteor Showers

There are no showers of great importance visible during this week. Meteors from the following radiants have been observed in previous years:—From Crater, R.A. 170°, Decl. 10° S.; near α Ursæ Majoris, R.A. 170°, Decl. 62° N.; from Virgo, R.A. 202°, Decl. 9° N.; from Aquila, R.A. 290°, Decl. 10° N.; and one with radiant at R.A. 234°, Decl. 46° N.

Stars with Remarkable Spectra

Name of Star	R.A. 1886·0 h. m. s.	Decl. 1886·0 ° ′	Type of spectrum
S Coronæ	15 16 45	31 46·7 N.	III.
τ^4 Serpentis	15 31 11	15 28·7 N.	III.
R Serpentis	15 45 26	15 28·8 N.	III.
367 Birmingham	15 59 41	47 33·1 N.	III.
47 Serpentis	16 2 58	8 50·3 N.	III.
371 Birmingham	16 3 7	8 55·1 N.	III.
δ Ophiuchi	16 8 22	3 23·9 S.	III.
V Ophiuchi	16 20 24	12 9·5 S.	IV.
α Scorpii	16 22 25	26 10·6 S.	III.
g Herculis	16 24 53	42 7·9 N.	III.
α Herculis	17 9 26	14 20·2 N.	III.

ON THE FORCES CONCERNED IN PRODUCING THE SOLAR DIURNAL INEQUALITIES OF TERRESTRIAL MAGNETISM [1]

In an article on terrestrial magnetism in the present edition of the "Encyclopædia Britannica," I have endeavoured to show two things:—

(1) That of all the various hypotheses which have been started with the view of explaining the solar diurnal inequalities of terrestrial magnetism, the most probable is that which considers these inequalities to be caused by electric currents in the upper regions of the earth's atmosphere.

(2) That in the neighbourhood of the North Magnetic Pole (judging from observations discussed by Sabine) such currents have in all probability horizontal components flowing in from all sides towards that pole, so that on one side of the pole this component will have a direction the reverse to that which it has on the opposite side of the pole.

Dr. Schuster (see Report of Magnetical Committee of British Association) has deduced from this the legitimate inference that here we must have a vertical current or component of currents, inasmuch as without this we cannot imagine a series of strictly horizontal currents flowing in from the circumference to the centre like the spokes of a wheel.

I think it is desirable that this method of discussion should be extended to the phenomena round the magnetic equator. This magnetic equator may be regarded as approximately coincident with the terrestrial equator. It is the line all along which the freely suspended needle points horizontally, just as the magnetic pole is the place at which the freely suspended needle points vertically downwards.

Now a little to the north of the magnetic equator we have, broadly speaking, the following phenomena:—

(1) When the sun is north of the line, the influence of the sun upon the declination-needle (as represented by that oscillation which culminates an hour or two after noon) tends to drive the North Pole to the west. But when the sun is south of the line this action becomes reversed, and drives the North Pole eastwards.

(2) Whether the sun is north or south of the line, its action upon the bifilar needle (as represented by that oscillation which culminates about noon) tends to increase the horizontal force.

Now let us go a little to the south of the magnetic equator, and we find the following behaviour:—

(3) When the sun is south of the line, the influence upon the declination-needle represented as above tends to drive the North Pole to the east. But when the sun is north of the line this action becomes reversed, and the North Pole is driven westwards.

(4) Whether the sun is north or south of the line, its action upon the bifilar needle, represented as above, shows that it tends to increase the horizontal force.

It is, indeed, well known that there is a north-hemisphere and a south-hemisphere action of the sun upon the declination-needle, the one being the reverse of the other, and the southern limit of the first action being the northern limit of the second. And furthermore this boundary line oscillates backwards and forwards, so that, when the sun is in the north, a station near the equator, but north of it, exhibits a more distinctively northern character of oscillation, while, when the sun is in the south, it will exhibit a more or less southern character in its oscillation.

If we now venture to ascribe the actions represented in (1), (2), (3), and (4) to currents in the upper atmospheric regions, we shall have—

(1) when the sun is north, caused by a positive current going from south to north;

(2) caused by a positive current going from west to east;

(3) when the sun is south, caused by a positive current going from north to south;

(4) caused by a positive current going from west to east.

The resultant of (1) and (2) would be a horizontal positive current going in a direction not far from south-west, and the resultant of (3) and (4) a similar current going in a direction not far from north-west. The analogy in direction as well as oscillation to the two systems of anti-trades is at once apparent, and it will be strengthened if we reflect that, in the magnetical as well as the meteorological system, we must have a vertical current at the equator. This current might probably be repre-

[1] Being the substance of a Paper recently read before the Literary and Philosophical Society of Manchester, by Prof. Balfour Stewart, F.R.S.

sented by one carrying positive electricity down or negative electricity up, whereas that at the North Magnetic Pole might be one carrying positive electricity up or negative electricity down. We say *probably*, because it is exceedingly difficult to imagine that either of these vertical currents goes through the lower regions of the atmosphere into the earth, and it is likewise very difficult to imagine that the system of currents is an open one. They must, therefore, somehow close themselves in the upper atmospheric regions, and we may thus perhaps imagine that, while we have an ascending current at the North Magnetic Pole, we have a series of descending positive currents at the equator.

Or, if we prefer to render the analogy between the meteorological and magnetical systems more verbally complete, we should say ascending negative currents at the equator and descending negative currents at the pole.

These vertical currents being supposed to be confined to the upper regions of the atmosphere, we might imagine that they ought to render themselves visible at the magnetic pole, where they are most concentrated. If so, they would appear as a luminous vertical curtain or fringe suspended in mid-air. This at once suggests to us that the well-known form and nearly continuous appearance of the aurora in these regions may be due to this cause, and may represent to us the vertical component of those currents which we have here supposed to be the causes of the solar diurnal magnetic variations. It must not, however, be supposed that in making this suggestion we imply that phenomena of an auroral nature are not likewise connected with magnetic disturbances.

It is to be remarked in conclusion that a system of atmospheric currents will act inductively on the terrestrial magnetic system, so that the final effect on the needle will be the conjoint effect of the currents above and of the magnetic change below. In the case of the declination it is our inability to express the force that acts near the equator or near the magnetic pole in terms of any conceivable general change in the magnetic system that induces us to look to atmospheric currents as affording us a simpler mode of expressing observed facts. This, however, does not hold for the horizontal force near the equator. A set of currents moving east in both hemispheres will produce by induction a definite and well-understood effect upon the terrestrial magnetic system. We do not, therefore, know how far the change produced by the sun upon this element is due to a cause above the needle or how much to magnetic change below; and in this respect the conclusions we have deduced may require modification.

ON THE DIURNAL PERIOD OF TERRESTRIAL MAGNETISM [1]

THE explanation of the daily variation of the magnetic forces observed on the surface of the earth will, in all probability, lead to the explanation of the mysterious connection between solar phenomena and terrestrial magnetism. For the increase in amplitude of the diurnal variation of the horizontal components of magnetic force forms one of the most striking effects accompanying the increase in sunspot activity. The daily variation, then, seems a most important symptom of solar ininfluence, and its investigation becomes a matter of great interest.

In the remarks which I wrote out for the Report of the Committee appointed by the British Association for the purpose of considering the best means of comparing and reducing magnetic observations, I pointed out the importance of adopting a suggestion, made already by Gauss, to apply the analysis of surface harmonics to the diurnal oscillations. It is well known that such an analysis would allow us to decide the question whether the immediate cause of the disturbance was inside or outside the surface of the earth; nor can there be two opinions as to the importance of definitely settling that question. At the time I wrote out my suggestions, however, it seemed to me that, as the causes of the disturbance had their seat in all probability close to the surface, whether outside or inside, that we should require a large number of terms in the expansion before we could arrive at a definite result.

In this I was mistaken, and it is one of the principal objects of this paper to show that the periodic variations adapt themselves with great facility to the analysis, and that even with the very limited quantity of material at our disposal we shall be able to arrive at most important results; results which within a short time might be made absolutely certain if additional observations at a few well-selected stations are taken. My results, as far as they go, point definitely to the region *outside the surface of the earth* as the locality of the periodic cause of the variation. It is easy to see that, if electric currents parallel to the earth's surface produce any disturbance, we can readily find out whether these currents are outside or inside the earth. As we pass through any current-sheet, the normal magnetic force remains continuous, but that tangential component which is at right angles to the current suffers a discontinuity depending on the intensity of the current. For a spherical current-sheet these components will always be of opposite sign. If we then find the distribution of magnetic potential on the surface of the earth from the horizontal components only, we should get by calculation a vertical component of different sign according as the cause is inside or outside. A comparison with the observed values will at once decide the question. A more careful analysis is necessary, if the causes are partly outside and partly inside, and we wish to determine their relative importance.

I believe that few practical magneticians at the present day read Gauss's memoir "On the General Theory of Terrestrial Magnetism," and the loss which cosmical physics has suffered in consequence is, as far as our generation is concerned, quite irretrievable. The memoir is a model of scientific reasoning, and full of suggestions which are as valuable now as they were fifty years ago. The investigations of Gauss are founded on the assumption of a magnetic potential on the surface of the earth, but that assumption requires justification in the case of magnetic disturbances. There will be no potential if there is a discharge of electricity through the earth's surface, and a variation of electric charge would be equivalent to a current. Calculation shows that electrostatic experiments on the surface of the earth would have shown before now if there was a sufficiently rapid change in electric potential to cause a disturbance of the magnetic needle. As regards an actual discharge, it is difficult to form an estimate, and we have therefore to fall back on magnetical observations, and see whether or not they seem to show that the line-integral of magnetic force taken round a closed curve vanishes. The calculations of the author, made on the assumption that it does vanish, seem to show a general agreement with fact; but some observations of Sabine, taken near the magnetic pole, would, if confirmed, point to a discharge in the Arctic regions.

The determinations of the diurnal variation of the magnetic variations show such a remarkable regularity everywhere except in the Arctic regions, and especially in latitudes between 20° and 60°, that we may as a first approximation express the westerly force (measured as change in declination) as the product of two quantities, one changing with local time, the other with latitude only. This assumption leads to the conclusion that the northerly component of force ought to be a maximum or minimum when the declination-needle passes through its mean position. This is very nearly true at Greenwich, Bombay, Lisbon, and Hobart. The agreement is not quite so good at the Cape of Good Hope and in St. Helena, but the observations at these places show some marked anomalies. It is found by observation that the variation in declination increases with the latitude, and we may as a first approximation put it proportional to the sine of the latitude. Writing γ for the westerly, χ for the northerly component of force, u for the co-latitude, λ for the longitude reckoned towards the east, and t for the local time, we may put

$$\gamma = \cos u \cos (t + \lambda).$$

It follows from this, on the assumption of the existence of a potential, that

$$\chi = \cos 2u \sin (t + \lambda).$$

The important point here is the factor $\cos 2u$, which changes sign at a latitude of 45°. If our equation is approximately right, the northerly force ought to be a maximum in the morning, a minimum in the afternoon in the equatorial regions where $\cos 2u$ is negative, while in latitudes above 45° the minimum ought to take place in the morning. This is exactly what happens, with the exception that the change seems to take place in latitudes smaller than 45°. At Bombay the *maximum* of horizontal force takes place at 11 o'clock a.m. At Greenwich the *minimum* takes place a little after that time.

At Lisbon ($u = 51°$) the phase agrees in summer with Greenwich, and in winter with Bombay, the Greenwich type pre-

[1] Abstract of a Paper read before the Manchester Literary and Philosophical Society, by Arthur Schuster, F.R.S.

ponderating; we may conclude that the latitude at which the change of phase takes place shifts with the season, and that its average position is not far south of Lisbon.

The good agreement of our formulæ with the observed facts encouraged me to deduce the vertical component of force. Measured downwards it should be

$$\sin 2u \sin (t + \lambda)$$

if the cause of the disturbance is outside the earth, but

$$-\tfrac{3}{2} \sin 2u \sin (t + \lambda)$$

if the cause of the disturbance is inside the earth.

Both expressions have their maxima and minima coincident with those for the northerly components of horizontal force, a fact which finds its confirmation in actual observation. They also show the phase of the vertical force to be the same for each hemisphere and not to change as with the horizontal force. But there is an important distinction: while the vertical force has its maxima and minima coincident with the maxima and minima of horizontal force at latitudes greater than 45°, in the equatorial regions the maximum of horizontal force ought to be coincident with the minimum of vertical force, and *vice versâ*, if the cause is outside the earth's surface; the opposite should be the case if the cause is inside.

At Greenwich the maximum of northerly force takes place at 7 p.m., the minimum at noon; the maximum of vertical force takes place at 7 p.m., the minimum at 11 a.m.

At Bombay the maximum of northerly force takes place at 11 a.m., the minimum at 9 p.m.; there is a very decided minimum of vertical force at 11 a.m; but there is no pronounced maximum; two minor maxima occur, one at 6 a.m. and the other at midnight.

As far as these results go they give an emphatic answer in favour of the supposition that a great part at any rate of the disturbing currents lie outside the earth's surface, a view which Prof. Balfour Stewart has often supported in the last few years. The results seem to me very encouraging, and I hope soon to be able to make use of more material and to obtain more accurate expressions for the various forces concerned.

If we make use of the actual observations of Bombay and Greenwich, we may calculate for each hour the intensity and direction of the currents which would produce the disturbance. This has been done, and the results have been collected in a table.

It is very remarkable how very nearly at the same local hours the currents flow north and south at Bombay and at Greenwich, namely, at 4 in the afternoon and between 7 and 8 in the morning. It is curious, moreover, to find how very quickly the current turns through the meridian: at Bombay, at 3 o'clock, it flows at an angle of 15° from the east, and at 5 already it flows due west, and remains almost unaltered in direction till 5 o'clock in the morning. At Greenwich the currents turn much less sharply, but they always flow east when the currents at Bombay flow west. The system of currents indicated is that approximately shown by the equations given in the paper, the phase, however, being different. Along the meridian on which the local time is 4, the currents flow from the equator towards the north; they turn round in our latitudes towards east and west, join on either side again to go south, where the local time is 7.30 in the morning, and come back along the equator.

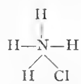
The strength of the currents is approximately of the same order of magnitude as the currents we are accustomed to send through our vacuum-tubes, but as the thickness of layer through which they are distributed must be very large compared to that on which we experiment, the current-intensity at each place is very small, far too small to cause luminosity. The currents, on the whole, are weaker at Greenwich than at Bombay, but, while they almost vanish at one time at Bombay, making the ratio of the strongest to the weakest current equal to 73, that ratio is only 3½ at Greenwich. The minimum at Greenwich in the early morning is as pronounced as the afternoon minimum, but much less so at Bombay.

On the whole, the numbers, both as regards direction and intensity, show such a remarkable regularity that there is good hope of obtaining a good mathematical representation of their distribution.

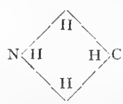
CHEMICAL AFFINITY AND SOLUTION

IN 1878 I read a paper to the Royal Society of Edinburgh, in which I stated my opinion, based on the results of a considerable number of experiments, that chemical combination solution and suspension of solids, such as clay, in water differ in degree only, and are manifestations of the same force; and that there seems to be a regular gradation of chemical attraction from that exhibited in the suspension of clay in water up to that exhibited in the attraction of sulphuric acid for water, which we call chemical affinity. Further, I stated that the attraction of chemical affinity is not, in all cases, at any rate, exhausted when a definite compound is formed, but has sufficient power left to form solution or suspension compounds. In 1881 I read another paper on chemical affinity and atomicity, in which I went a step further, and endeavoured to show that the theory of valency as usually held was incorrect in assuming chemical affinity to act in units or bonds, and insufficient to account for the various phenomena of varying atomicity, or valency, molecular compounds, crystallisation, solution, alloys, &c., and that all these varied phenomena were simply due to the chemical affinity of the elementary atoms, and that the difficulties disappeared if we got rid of the idea of the indivisible units of chemical affinity, and considered it as a whole acting all round, and spreading out, so to speak.

As an illustration of my views, I considered the compounds, HCl, NH_3, and NH_4Cl. In HCl we have two monovalent elements combined, and their chemical affinities completely neutralised or satisfied. In NH_3 we have N considered as a trivalent element satisfied with three monovalent elements. Now these two completed, neutralised or satisfied compounds combine with one another to form the third compound, NH_4Cl. How is this? The usual answer is that N sometimes acts as a pentavalent atom, and in this particular case does so, and the compound is represented graphically thus:



I pointed out that this explanation was most unreasonable, and to me, indeed, incredible, because it supposes that N, which has usually such a weak affinity for Cl, can nevertheless decompose the HCl into its constituent atoms, and fix the atom of Cl to itself. While on the other hand the Cl leaves the H, for which usually its affinity is so great, and unites itself to the N, for which usually its affinity is so small, and this while the atoms are in such close proximity, as they must be in a molecule, and with so many hydrogen atoms allied with it. My explanation was simply this. The affinity of the Cl acts on all the four atoms of H, and the affinity of the N does the same; and thus the whole molecule is held together, and may be represented thus:



I did not, however, exclude the idea that the Cl and N react on one another to some extent, but the *main* cause of the combination is as stated above.

Since these papers were read chemists seem to me to be coming more and more to my views in this matter. Thus Pattison Muir in his "Chemical Principles," says: "It seems to me that a most important step will be made if the bond theory of valency is generally abandoned; with it will go all those quasi-dynamical expressions, the offspring of loose and slipshod ways of thinking which have gathered round that strange anomaly, a unit of affinity employed as a variable standard for measuring nothing." Further, he says, in reference to the behaviour of acetic acid vapour when exposed to a high temperature: "If this is so, we evidently have a series of substances beginning with solution of salts or gases in water and proceeding through crystallisation and acetic acid vapour at low temperature, which connects mechanical mixtures on the one hand with stable gaseous compounds on the other."

Again, Professor Armstrong, in his address to the Chemical Section of the British Association at Aberdeen last year, says that in his view molecular compounds are held together by what, for want of a better name, he calls surplus, or residual affinity. In view of these and many other similar expressions of opinion, all tending in the same direction, I may perhaps be excused for again bringing forward the subject.

In the present paper, however, I shall confine myself mainly to the subject of solution, for two reasons. First, because it seems to me that if we can satisfactorily account for this part of the subject, the remainder will be easily and naturally explained; and, second, because from a study of Thomsen's researches on thermo-chemistry, as given in Muir and Wilson's recent work on that subject, I have obtained data which seem to me almost to demonstrate the truth of my views on the subject of solution.

In my paper of 1881 I explained solution to be due to the affinities of the constituent elements of the body dissolved for the constituent elements of the solvent. Thus NaCl dissolves in water because of the affinity of the Na of the salt for the O of the water, and of the Cl of the salt for the H of the water. These affinities not being strong enough to cause double decomposition, an indefinite compound is formed having the properties of what we call a solution. If this explanation be correct, we should expect that the relative strengths of the affinities of Na, O, Cl, and H should have an effect on solution, and that if we substituted another metal for Na whose affinity for Cl and O was greater or less, we should have a corresponding change in the solubility of the salt. If, for instance, this other metal had greater affinity for Cl and less for O, we should expect the salt to be less soluble, because the Cl would be held more firmly, and could not act so energetically on the H of the water, while the action of the metal on the O of the water would also be less. Now it may be admitted generally that the heat evolved in similar chemical operations is a measure of the chemical affinities of the elements concerned, or at least of their relative affinities. With these explanations, let us consider some of Thomsen's results. He finds as the result of numerous experiments that as the atomic weight of the metal increases in similar compounds of Mg, Ca, Sr, and Ba,

(1) Heat evolved in production of MCl_2 *increases*
(2) ,, ,, MO *decreases*
(3) ,, solution of MCl_2 ,,
(4) Solubility of MCl_2 in water ... ... ,,

These results apply to the alkali metals also.

To make these considerations plain, consider the following table:—

Metal	Heat of formation of chloride	Heat of formation of oxide	Heat of solution of chloride
Mg	151,010	146,000	35,920
Ca	169,820	130,930	17,410
Sr	184,550	128,440	11,140
Ba	194,740	124,240	2,070

Now the order of solubility of these chlorides is exactly as these results would lead us to expect, $MgCl_2$ being most soluble, and $BaCl_2$ least so, while $CaCl_2$ and $SrCl_2$ are intermediate; and the whole result is exactly what we should expect if my explanation of solution be correct. The chloride of the metal whose affinity (as measured by the heat evolved) is greatest for Cl, and least for O is the least soluble. Again, let us take the following series of elements in which the heats of combination with equivalents of either Cl or O gradually decrease (excepting Na for O), but that of Cl much faster than that of O, so that after passing Al the heat of combination of one equivalent of O is greater than that of Cl, and consider the action of the chlorides towards water:

NaCl Soluble.
$MgCl_2$,, but decomposed on evaporation.
$AlCl_3$,, forms crystals with water, and decomposed on further heating.
$SiCl_4$, PCl_3, PCl_5 } In contact with water, more or less quickly decomposed.
SCl, SCl_4 } Instantly decomposed in contact with water.
Cl gas Dissolves in water, which it slowly decomposes on exposure to sunlight. Also at low temperature combines with water, forming compound $Cl5H_2O$. The behaviour of this gas is interesting, becouse it brings gases under the same principle of solution.
KCl Soluble.

We have thus a regular gradation of change, from simple solution through double decomposition to solution again, according as the affinities of the elements for Cl and O vary. Thus solution appears as a periodic function of the elements.

Let us take another case, where the affinities of the elements for Cl and O again regularly decrease, but where the affinity for the O diminishes faster than that of the Cl, and note the result. The following group of elements represents this case:

NaCl Soluble.
CuCl Insoluble, or nearly so.
$CuCl_2$ Soluble.
AgCl Insoluble.
AuCl ,,
$AuCl_3$ Soluble.

Now it will be observed that Cu, Ag, and Au have a small affinity for O compared to what they have for Cl; especially is this the case with Ag, and when these elements combine with only one atom of Cl, the chloride is insoluble; the affinity of the single atom of Cl for the H of the water, combined with the small affinity of the metal for the O of the water, is too weak to produce solution; but as soon as one or more atoms of chlorine are taken up, the compound becomes soluble through the increased affinity acting on the water.

All this is quite consistent with the view of solution I have proposed. In truth, this view is the most simple and natural explanation of the facts. There are not sufficient data to be obtained to trace these actions through all the various groups and series of elements, but there are numerous indications that they are regular recurring phenomena. I need only mention the analogous behaviour towards water of the chlorides of P, As, Sb, Bi and S, Se and Te.

I have chosen the chlorides to illustrate the principles of solution because of the simplicity of their composition and action, and also because the data are more complete for them than for other salts, but the same principle can be traced through all.

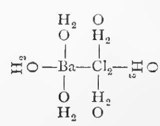
Let us consider, however, for a moment the solution of the oxides. In this case, as the metal is already combined with O, it is not likely to have so much effect on the O of the water. We see, however, the same action taking place. Thus take the following group and their heats of combination and solution:

Metal	Heat of formation of oxide	Heat of solution of oxide
Mg	146,000	2,960
Ca	130,930	18,330
Sr	128,440	29,340
Ba	124,240	34,520

Now again we find that the oxide which has the greatest heat of formation is the least soluble, because the elements are held more firmly together, and less affinity is left to act on the water elements. Thus MgO is almost insoluble, while BaO is the most soluble of the group, and CaO and SrO intermediate. This order is the inverse of that of the chlorides, as the heat of formation is also inverse.

Many examples of the close relationship between the heats of formation and the heats of solution might be given. For example, if we neutralise the hydrates of the above oxides with a solution of HCl, we find the heat evolved approximately the same in all cases, being about 27,600 units. At first sight this appears very curious, seeing their affinities (as measured by heat evolved), for Cl and O vary so much and inversely; but the explanation is obvious enough. The heats of solution of the various compounds decomposed and formed exactly compensate for the variations in the heats of combination; what is lost in one way is gained in another.

Closely connected with solution is the subject of crystallisation. This also is most satisfactorily explained, if the principle I contend for be admitted, and regular structure necessarily follows. For instance, in such a compound as $BaCl_2\ 6H_2O$, the atoms of the molecule must be arranged somewhat after the following fashion:



There are many other points connected with this subject, but as the data I can obtain are fragmentary, I shall content myself at present with indicating the direction of my inquiries.

(1) The affinities, measured as before, of the series Na, Mg,

Al, Si, P and S, for Cl, regularly diminish if we take the amount for one atom of Cl in each case; but if we take the actual maximum amount of Cl with which each element in the series combines, a very different result comes out, because while Na combines with one atom of Cl, Mg combines with two, and Al with three, and so on. This leads us to make a distinction between the intensity and quantity of chemical affinity, so that while the *intensity* of affinity in this case regularly diminishes, the *quantity* rises to a maximum in Al, and then diminishes towards S. There is thus a spreading out of affinity which lowers its intensity, and in this there seems to me a gradual approach to solution. I have traced the same phenomena in some oxides, and it is interesting to note that the atomic weight of Al, whose affinities for Cl and O are nearly equal, is almost exactly midway between the atomic weights of O and Cl. It is, so to speak, the point where the two curves of affinity cross one another. On the one side the affinity for Cl relatively to that for O increases, and on the other side decreases. This may throw some light on the peculiar properties of Al. Fe, which is in many respects analogous to Al, and has an atomic weight about twice that of Al, and almost midway between Cl and Br, shows somewhat similar relations towards Cl and O. It is also to be noted that while the maximum affinity for Cl is at Al, that of O is at Si. It would be interesting to trace curves of intensity and quantity for other elements such as H and S. Much light might be thrown on many chemical facts.

(2) If we take the heats of combination of Cl, Br, or I, with any element, the law seems to be that the amount of heat diminishes as the atomic weights of Cl, Br, and I increase, modified, however, by the atomic weight of the element with which they combine. Thus, take what may be called the normal case, viz. combination with hydrogen, we have

Atomic weight of Br =	80	of I =	127
,, ,, Cl =	35·5	Cl =	35·5
Difference ...	44·5		91·5

Heat of combination HCl =	22,000	of HCl =	+ 22,000
,, ,, HBr =	8,440	HI =	− 6,040
Difference ...	13,560		28,040

Now, 44·5 : 91·5 : : 13,560 : 28,040 almost exactly. With Al again the above differences are as under—

Heat of combination $AlCl_3$ =	160,980	of $AlCl_3$ =	160,980
,, ,, $AlBr_3$ =	119,720	AlI_3 =	70,590
Difference ..	41,260		90,390

Now it is evident these are not exactly in same proportion as the H compounds, and with Na and K compounds the discrepancy is even greater, but still near enough to suggest the general law as stated above.

(3) If the explanation given of crystallisation be correct, we may go a step further. If we take water alone without any salt in solution, there will be, in my view, attraction between the H_2 of one molecule and the O of another, and *vice versâ*, and if the heat of the liquid be diminished sufficiently, that attraction will cause cohesion of the molecules, and will produce solid water or ice, the regular structure of which is caused by the symmetrical arrangement of the atoms. This again leads on to solids in general, for there is little doubt that atoms of the same kind have affinity one for the other; and thus the various conditions of matter, solid, liquid, and gaseous, may be due to chemical affinity of the constituent atoms, modified in various ways by the kinetic energy of the system.

It will thus be seen that my view of chemical affinity is quite opposed to the idea of its being a sort of arbitrary force acting in units or bonds, but I consider it acts between all atoms of matter, whether of the same or different kinds in varying degrees of intensity and quantity, producing combination of more or less stability, graduating from the so-called mechanical mixture of clay and water up to the irresolvable molecules of the permanent gas, condensing by its action the gas into the liquid, and the liquid into the solid, chemical compounds being combinations in definite proportions of more or less stability. In fact, in this case as in all others, there are no hard and fast lines in Nature, but every phenomenon graduates by almost imperceptible degrees into another.

W. DURHAM

THE JAPANESE NATIONAL SURVEY AND ITS RESULTS

DURING the past five years a work of great national and scientific importance has been proceeding in Japan; little has been heard of it in Europe, and none of its results have been visible amongst us in England until within the last few months. The Japanese National Survey, under the superintendence of Dr. Naumann, formerly Professor of Geology in the University of Tokio, has during the period above mentioned been steadily progressing; it has revealed hitherto unknown features of the country, and has thrown a flood of light on its geography, geology, and resources, actual and possible. A period has now been arrived at in the history of the Survey: its Director, after five years' labour at this particular work, and as many more in the Chair of Geology in the University of Tokio, returns to Europe, leaving the task to be carried out by the Japanese whom he has trained. Some tangible results of the work have, as already mentioned, been for the first time placed before the European public. In the rooms of the Royal Geographical Society might a short time ago be seen by any one who desired to do so a series of maps, printed and manuscript, with numerous plans, illustrations, and sketches, exhibited by Dr. Naumann, and representing to some extent the work of five years. Samples of these were also to be seen at the Exhibition of Geographical Appliances in Great Marlborough Street, amongst others an orographic map of Japan, and several illustrations—one of the mountain summits in the neighbourhood of the active volcano Asamayama being especially striking. The present, then, seems a suitable time for describing the Survey, the work it has set before it, that which it has succeeded in doing so far, and the effect of its work on our knowledge of the country.

When Dr. Naumann laid before the Japanese Government, about six years ago, the plan for a national survey, it was based mainly on economical considerations. It was pointed out that by means of such a survey the resources of the country, hitherto undeveloped, and to a considerable extent unknown, would be investigated systematically. At the commencement of the undertaking there were hardly any maps in existence that could be utilised with safety. The work was facilitated by the materials derived from a Japanese astronomical-geodetic survey carried out at the beginning of the present century, which fixed the position of the coast-line and the courses of some of the main roads. The coast surveys of the English Admiralty, also, and of the navies of other countries, as well as the few results of the trigonometrical survey of Japan, were found of use. But the interior of the country, in all that related to orography and geology, was still a *terra incognita*. In every other respect those rough Japanese compilations of older map-work of a mediæval type, though worked out by the application of some of the principles of European cartography, were totally insufficient. Hence at the outset it was necessary to undertake a topographical survey, so that not only matter, but also space, became the object of investigation. From the beginning the necessity of combining observations with measurements was emphasised. Inasmuch as the economical position of the country depends on agriculture, special attention had to be paid to the relations between the qualities of the soil and its cultivation. Hence the Survey started with three departments intrusted with field-work—one topographical, the second geological, and the third agronomical. A fourth, the chemical section, was created to investigate and test the materials collected by the geological and agronomical sections as to their composition and technical applicability. The plans laid before the Government, and approved, placed the scale of the maps, which were to be published in three series corresponding to the three divisions of the Survey—one topographical, one geological, and one agronomical, at 1 : 200,000. The maps were to be 0·456 × 0·277 metres for publication, and each series was to contain ninety maps, each of which corresponded to half a degree division, reckoned on the meridian of Greenwich. Two editions, one in English and one in Japanese, were to have been published. The scale for the field-work was 1 : 50,000. Subsequent experience demonstrated the substantial accuracy of these plans. It is of course essential in surveys like this that the various divisions should work side by side, and advance with equal and regular steps. But a consequence of the conditions under which work of this kind is conducted in Japan was that this co-operation, which was so necessary to the common aim, could not be carried out. The agronomical and chemical sections ultimately came under the sole direction of a Japanese Commissioner, and only the topographical and geological sections remained together under the immediate control of the Director who had laid the foundations of the whole undertaking. In order to understand the ill-effect of this division, it is only necessary to mention that the agronomical section worked on a different scale from the topographical and geological, and did topographical work for its own purposes, independent of that done by the topographical section!

The difficulties at the outset were numerous and important. First of all there were those connected with the nature of the work itself. The Japanese chain of islands is little more than a huge and complicated range of mountains, which is in parts hardly passable. Travelling along the main roads in Japan is not always very pleasant, but there are no particular hardships. Amongst the mountains, however, progress can only be made under great difficulties; and when a survey has to be made in these regions it demands all the energy and strength of a very strong man. It was necessary, too, in the present instance, in view of the economical wants of the country, to do the work in the shortest possible time. The period originally arranged was twelve years for the wh le work; and what has been actually done since the beginning showed that it was possible to complete the Survey in this time had the staff been complete and the proposed organisation strictly disciplined for, and directed to, the purpose in hand, as might have been done. But, in fact, the staff never was complete, and the regular and constant prosecution of the Survey in course of time became more and more difficult, mainly owing to financial considerations. The year before last, for example, no field-work was done at all for this reason. At the outset, too, the training and educating of the assistants and cartographers presented great difficulties, which, owing to the energy and intelligence of the Japanese cooperators, were ultimately overcome. Again, when the stage of publishing was reached, obstacles of a peculiar kind were met with. To publish the maps abroad was not to be thought of. The Department had to pay the cost of publishing out of its own funds, and the work had to be carried out by Japanese. Experiments were made with lithography and heliogravure, but it is found impossible to adopt either of these methods in Japan. Ultimately the Toyodo Engraving Company in Tokio was intrusted with the work, under the constant superintendence and control of the director, and it is curious to note that the maps are all *etched* on copper, not engraved. Much more might be said of the difficulties which had to be overcome in this wholly new undertaking in Japan; but a commencement was made with the work towards the end of 1880. It soon appeared that the plans of the Survey could only be successfully carried out by a reconnaissance of the whole country in the first place. It appeared necessary to obtain first a general view of the conditions of Japan before the special and main work could be effectually commenced. The broad features, internal and external, of the mountain system of the country had to be ascertained, particularly for the purpose of allowing uniform representation in the special maps to be published later on. The Director commenced this preliminary survey early in 1881, and decided to prosecute it as far as possible in person. This reconnaissance was completed in the beginning of 1884, with a little help from assistants in regard to subordinate details. As an example of the work which this entailed, it may be mentioned that in two years he travelled, mostly on foot, 2000 miles, and that during the five years he was engaged in the work his routes covered about 5000 miles. The surveys in 1881 lasted from May to November, in 1882 from September to December, and the last great journey was from July 1883 to February 1884. The intervals which were spent in the capital were fully occupied; the orographical and geological sketch-maps (recently exhibited in London), as well as many others, were then produced. On this general survey of the country a topographical and geological map on a scale of 1 : 400,000, in five large sheets, was prepared. The first of these, embracing the topography of Northern Japan, has already been published, and might have been examined with others in the Royal Geographical Society. The other parts are in hand, and the record is doubtless already complete in manuscript.

Both in the reconnaissance and the principal survey, the method employed in the field-work was partly that of flying surveys. The main object was to obtain in the shortest possible time a view of the natural conditions of the country, and to produce a map which would be useful for economical and scientific purposes. The very detailed surveys of European countries could not, therefore, be taken as examples to be followed. The fundamental consideration was, above all, the economical requirements of the country. Even for military purposes in Japan, a smaller scale, allowing of the application of simpler methods and more rapid progress, is preferable for field and map work. In Tokio there is also a Survey Department attached to the General Staff, but it is based on Western methods, and on account of the very large scale adopted many generations must elapse before it is completed. In 1884, when disturbances broke out in the Saitama prefecture, the military authorities discovered their lack of maps, and they were compelled to obtain maps of the district from the Geological Survey. After this experience, and after the publication of the first sheets of the special map of the Survey, the General Staff would no doubt readily understand the advisability of a system such as that applied by the Geological Survey. During recent years in Japan interesting results were collected respecting the methods necessary for surveys where rapid progress is required. With regard, for instance, to the amount of work which can be performed in a limited time, the sketches exhibited in the Royal Geographical Society prove of much interest for military, exploring, and colonial surveys. It happens frequently that the practical geographer is compelled to explore or survey a given region in the shortest possible time. During the topographical and geological field-work of the Japan Survey, one of the most important rules observed was that of plotting the relations of space measured or observed in the particular places at once, and according to a definite scale (1 : 50,000). The first designs of the maps were, so to say, made in the field in the face of the objects to be represented. In this way the work of the topographer was made as independent as possible of that of the cartographer; under any other plan the final result would be more arbitrary. The amount of field-work done each day appears to reach the highest limit attainable. In 1881, for instance, Dr. Naumann surveyed, in some cases, routes of 32 kilometres in length, and this during the hottest summer months, and in difficult mountainous country. The daily average of Dr. Naumann during the reconnaissance surveys of 1881 amounted to 20 kilometres, while the average for the Japanese assistants was 12 kilometres. With regard to the degree of accuracy of the surveys thus made, it appears from an article on them, published in *Petermann's Mittheilungen* for January 1884, that the results, even with this great rapidity, were highly satisfactory. The route Miyako-Morioka, in Northern Japan, for example, shows an error of only 0·6 per cent. for the distance between the terminal points, which in a straight line is 68 kilometres, while the actual route surveyed is 100. For reconnaissance purposes this route was surveyed in five days.

At the commencement of the Survey the technical staff consisted of four Europeans—viz. a director, topographer, agriculturist, and chemist—and twenty-two Japanese assistants—viz. one geologist, five topographers, five agriculturists, five chemists, and six draughtsmen. The foreign chief of the agricultural section left the Japanese service at the beginning of 1881, and the foreign topographer a year later. The services of another foreign agriculturist were obtained at the end of 1883. At present the technical staff consists of two Japanese directors, one European in charge of the agricultural section, and thirty Japanese assistants. The results of the Survey are, in the first place, in the shape of maps, of which the following is a list:—

A. *General Maps on the scale of* 1 : 874,000 (at present in manuscripts.

(1) Geological map by Dr. Naumann and his geological assistants. On this map the distribution of the following geological groups and rocks shown:—Primitive gneiss (violet); crystalline schists (light rose carmine); Palæozoic group (neutral tint); Mesozoic group, Triassic, Jurassic, and Cretaceous (blue); Tertiary (light green); volcanic tuff, corresponding to very modern Tertiary (light yellow); granite, quartz porphyry, porphyry, porphyrite, diorite, diabase, and volcanic rocks.

(2) Oroplastic map by Dr. Naumann and his topographical assistants. The surface shape is represented by horizontal layers of 200 metres; the depths of the surrounding seas are shown on the same system. The mountains are marked by successive shades of brown, the sea by shades of blue. This map was in the late Exhibition of Geographical Appliances.

These two maps are mainly compiled from Dr. Naumann's reconnaissance surveys.

(3) Magnetic map by S. Sekino, representing the isogonic, isoclinic, and isodynamic lines of Japan, constructed from about 200 magnetic observations made at as many different stations.

(4) Map of the great historical earthquakes, volcanoes, solfataras, and hot springs of Japan, by Dr. Naumann and two of his assistants. The relative frequency of earthquakes in different parts of the country is indicated by different shades of brown. The limits of the areas of disturbance of some of the most remarkable earthquakes are likewise given.

B. *Maps Printed and Published.*

(5) Reconnaissance map, Division I., containing the northern part of the main island, from the original survey of Dr. Naumann and his assistants (Tokio, 1884). As already mentioned, this map is on the scale of 1 : 400,000. The mountains are represented by curves of equal height, 40 metres apart. The map is printed in three colours—the mountains brown, the water blue, while the skeleton and writing are black. The surface shape is clearly shown, and the system of representing the mountains is peculiar, and novel at least in a map of such small scale. The curves of equal height are directly used for the production of shades, which latter indicate the amount of slope. Great difficulty was encountered in reproducing this map. There can be no doubt that 40-metre curves applied to a 400,000 scale map represent the utmost limit attainable at present. In the case of an inclination of 45°, which occurs here and there, though rarely, the curves approach each other so closely that a zone of 1 mm. in breadth contains no less than ten lines! There are two different editions of the reconnaissance map—one with Roman, the other with Japanese, lettering. On other grounds all these maps are of interest, for they are the first artistic reproduction of the results of a regular topographical Survey in the far east of Asia.

(6) The three first sheets of the special Survey, showing the topography of the section Yokohama, Idsu, and Kadzusa. Here also there are two editions. Scale 1 : 200,000, and the mountains are shown by curves of equal height 40 metres apart.

(7) Index-sheet, containing the divisions of the whole country into five sections for purposes of the publication of the reconnaissance map, and into ninety sections for the special map. A short statement gives the progress of the Survey up to 1884, while the various signs employed in the maps are explained.

Besides the maps here specified, numerous designs, geological sections, landscape representations, tables, &c., have been made. A large number of practical reports were made for the Government, some of which have been published, but only in Japanese, and they are therefore inaccessible to the rest of the world. Among the papers thus furnished by the Director himself were reports on the waste of ores in Japan, on slate deposits and their utilisation, on Japanese building-stones, on the moving sand-dunes on the coast of Satsuma and how to fix them, on Japanese mineral springs, on the occurrence of gold and copper in various localities, and others.

As to the scientific results obtained by the Survey, they are of much general interest, but it is impossible in the space at our disposal to do more than refer to them cursorily. Those specially interested in the geological work may consult Dr. Naumann's book on the subject, "Bau und Entstehung der japanischen Inseln" (Berlin, Friedländer Sohn, 1885). Almost all systems have a part in building up the colossal mountain-range forming the Japanese islands. The occurrence of Devonian, Carboniferous, Triassic, Jurassic, Cretaceous, and Tertiary, was established by well-characterised fossils. A remarkable discovery of Upper Cretaceous Ammonites was made in the Island of Yezo, which Dr. Naumann proves are identical with Indian species of corresponding age. The considerable collection of Tertiary plants is now being studied by Prof. Nathorst, and his researches promise some interesting results, as appears from some preliminary notes already published by him. A monograph on Jurassic plants by Mr. Yokoyama, one of Dr. Naumann's assistants, will shortly appear. In early Tertiary times the Japanese islands contained numbers of elephants, identical with the celebrated species belonging to the old Indian Siwalik fauna (Dr. Naumann, "On Japanese Fossil Elephants," "Paläontographica," xxviii. 1). Triassic strata have yielded important fossils corresponding to the well-known *Monotis salinaria* of the Alps. Another important result of the Survey is the discovery of Radiolarian slates in almost every part of the archipelago. These are of great age, being probably older than the Carboniferous limestone, and they are nothing else than hardened mud of the deepest parts of the ocean bottom. Radiolarian mud occurs at present in depths of from 4200 to 8400 metres in the western and central parts of the Pacific Ocean, as ascertained by the *Challenger* Expedition. The mud, as well as the slates, is in great part made up of the microscopical skeletons of Radiolarians, and we learn that at remote periods the conditions at the greatest depths of the ocean have been nearly the same as at present, and that in Palæozoic times a great part at least of the Japanese chain was deeply submerged beneath the sea. Great scientific value must also be attributed to the results respecting tectonic geology, which are perhaps the most prominent of all. The Japanese island chain is one of the finest examples of a mountain-range of unilateral structure; and there cannot be the slightest doubt that it has been shifted by forces acting from the side of the Japan Sea towards the side of the free ocean. Almost all the eruptive and volcanic rocks are confined to a zone facing the Sea of Japan, while the outer zone is for the greater part made up of folded larger masses of Palæozoic and pre-Palæozoic times. Very striking, too, is the great transverse depression, introduced by Dr. Naumann into scientific nomenclature by the name of Fossa Magna, which crosses the main island not far from the capital. It appears that this depression is a kind of fissure or cleft produced by another chain of mountains running from Vries Island to the Bonin Islands. The movements going on in this latter chain may have entered the Japanese chain so as to split it. Some of the largest volcanoes of the country—as for instance the celebrated Fujinoyama—issued from that fissure. An inspection of the geological map shows clearly how the advancing folds were stopped by the Fossa Magna, so that they curve back and go around it. Last, but not least, the results concerning the magnetism of the earth may be mentioned. As shown in the magnetic map mentioned above, the magnetic curves are curiously irregular, and these irregularities have an evident connection with those of the geological structure. The Fossa Magna causes the isogonic lines to describe a large irregular curve, like the folds of the geological strata. Dr. Naumann, we believe, is preparing a paper on this subject for the Royal Society, where a fuller treatment of this phenomenon than he has hitherto given may be anticipated.

It is to be regretted that the Japanese Government does not appear sufficiently aware of the importance of a work such as that carried out by its Geological Survey. Its economical value is probably that which would appeal most strongly to a Government, and of its utility from this point of view there can be no doubt. The fundamental ideas with which the undertaking started should be revived: the various sections of the Survey must advance with even step, otherwise the work cannot fail to be irregular and dislocated. It may be hoped, too, that the Japanese will know how to utilise the invaluable experience laboriously collected by the Survey during the past five years.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—An Examination for Minor Scholarships at Downing College will be held early in June. These Scholarships will be awarded for Law, or certain branches of Natural Science. Persons who have not entered at any College in the University are eligible to these Scholarships, which will be of the value of 50*l.*, and tenable until their holders are of standing to compete for a Foundation Scholarship. Further information will be given by the Tutors of the College.

SCIENTIFIC SERIALS

Archives Italiennes de Biologie, tome vii., fasc. 1, Rome, February 1886, contains:—Studies on the drainage of the Roman Campagna, part 5, by C. Tommasi-Crudeli, concludes with the expression of his opinion, based on very numerous facts—(1) that the proposed artificial draining of the Ostian and Maccaresan marshes, and their reclamation, will augment in a great degree the malaria exhalations from these basins: and (2) that the hygrometric condition in which the subsoil of the reclaimed district would exist would render it very probable that such malaria exhalations would be persistent. He believes that malaria is produced on the earth, and not on the water, and when an area is covered with a sheet of water, and while it is covered, it is free from malaria.—On the minute anatomy of the central nervous organs, by Prof. C. Golgi.—On periodic and superfluous respirations, by Prof. A. Mosso (eight plates).—The respiratory movements in health are not always uniform in sleep and during moments of deep repose; the respiratory effort decreases and augments. This peculiar form the author calls "periodic respiration," and any excess of respiration beyond the actual needs of the tissues and blood he calls "superfluous respiration." Many phenomena of interest are described in this memoir.—Contribution to a knowledge of the physiological effects of cocaine, by Dr. C. Sighicelli.—On the physiological action of thalline, by Dr. G. Pisenti.

Schriften der Naturforschenden Gesellschaft in Danzig, Band vi. Heft 3 (1886).—We note here a copiously-illustrated account by Drs. Lissauer and Conwentz of the various antiquities which have been found in the Vistula-Nogat delta, ranging from the Neolithic period to Roman times; also a curious collection, by Herr Triechel, of sayings of the country folk in West Prussia, about plants.—Herr Helm and Herr Brischke report on insects found in amber.—The remaining matter largely relates to local botany.

Bulletin de l'Académie Royale de Belgique, February.—Application of the telephone to the discovery of faults in electric lines, by Eric Gerard. A new and ingenious method is described for determining by means of the telephone the spot where an underground telegraph line presents any accidental solution of continuity without the necessity of opening the ground and exposing the section of the wire where the break is suspected to exist. Owing to its extreme sensitiveness, the telephone communicates all signals transmitted by the underground conductor during the examination; but when the fault is reached, it remains silent, thus indicating the spot where search should be made for the defect. The method may be made applicable to submarine cables.—Earth microbes and their action in stimulating the growth of the higher vegetable species, by E. Laurent. In order to ascertain how far these micro-organisms are necessary to the life of the plant, the author has recently made some experiments: (1) in natural soil; (2) in soil first sterilised and then inoculated with microbes taken from the natural soil; (3) with soil rendered absolutely sterile; (4) with sterilised soil to which mineral manures were afterwards added. These experiments clearly showed the importance of the microbes, whose functions would seem to be identical with those of nitrification. They seem to prepare the needed inorganic food of the plant by decomposing the organic matter present in the ground.—On the influence of lunar attraction on the mercurial barometer, by J. Liagre. This was in reply to some remarks of M. Folie, who questioned the author's statement that atmospheric tides cannot be determined by the mercurial barometer. He repeats that lunar attraction cannot be appealed to in order to explain M. Folie's law that atmospheric pressure is lowest when the oceanic tides are highest.—A simple and practical method of determining the magnetic declination of any place whose meridian is unknown, by F. Folie. It is shown that the difficult and troublesome process of fixing the meridian may be dispensed with by employing a method based on the simple fact that, when the height of a star is equal to its declination, taken with its sign or opposite sign according as it is in the northern or southern hemisphere, its azimuth is the supplement of its horary angle, or else is equal to this angle itself.—Notice of some geological specimens from the islands of Cebu and Melanipa (Philippines), by A. F. Renard. A study of these specimens, collected by Mr. Buchanan in 1874, seems to show that to Cebu and Melanipa may also be extended the interpretation already admitted for the larger islands of the archipelago regarding the schisto-crystalline character of the underlying rocks, and the presence of eruptive rocks of the archæan type.—The same author contributed two other valuable papers on the geological constitution of the Ternate volcano and of Mount Gûnong-Api, in the Banda Archipelago.

Rendiconti del Reale Istituto Lombardo, March 4-18.—Positivism and evolution, by Prof. A. Buccellati. It is argued that Comte's theological, metaphysical, and positive cycle may perhaps represent the general sequence of mental evolution, but cannot be accepted in a strictly chronological sense. It confines the human mind in too narrow limits, and it must be obvious that all three phases of thought have been simultaneously at work in varying degrees of intensity at all times. Such an exclusive succession is illogical, and opposed alike to history and to the very constitution of the mind, which passes readily and unconsciously from analytic observation to synthesis, and from the inductive to the deductive method.—On the systems of surfaces and their rectangular trajectories, by G. Morera.—Meteorological observations made at the Brera Observatory, Milan, during the month of February.

SOCIETIES AND ACADEMIES

London

Royal Society, March 25.—"On the Minute Anatomy of the Brachial Plexus." By W. P. Herringham.

Dr. Herringham had traced by dissection the fibres of the several nerve roots from the spinal cord through the net of the plexus into the various nerves given off from this, and down these nerves to their final destination, whether motor or sensory. He found—

(1) That any given fibre may alter its position relative to the vertebral column, but will maintain its position relative to other fibres.

(2) That, in the motor nerves, (*a*) of two muscles, or of two parts of a muscle, that which is nearer the head end of the body tends to be supplied by the higher, that which is nearer the tail end by the lower nerve; (*b*) of two muscles that which is nearer the long axis of the body tends to be supplied by the higher, that which is nearer the periphery by the lower nerve; (*c*) of two muscles that which is nearer the surface tends to be supplied by the higher, that which is further from it by the lower nerve.

(3) That, in the sensory system, (*a*) of two spots on the skin that which is nearer the pre-axial border tends to be supplied by the higher nerve; (*b*) of two spots in the pre-axial area the lower tends to be supplied by the lower nerve, and of two spots in the post-axial area the lower tends to be supplied by the higher nerve.

A table was also given of the muscles classified according to the spinal root which supplied them. The paper was based on fifty-five dissections.

Physical Society, April 10.—Prof. Balfour Stewart, President, in the chair.—The following communications were read:—On the cause of the solar diurnal variations of terrestrial magnetism, by Prof. Balfour Stewart, LL.D., F.R.S. The author commenced by reviewing various theories that have been advanced to account for the solar diurnal inequalities of terrestrial magnetism. That they can be due to the direct magnetic action of the sun is highly improbable, since terrestrial analogies would lead us to infer that matter at the temperature of the sun is quite incapable of possessing magnetic properties, and also from the fact that changes in the range of the daily variation lag behind corresponding solar changes in point of time. The hypothesis of Faraday, that the observed variations are the result of the displacement of the magnetic lines of force due to the varying temperature, and consequently varying magnetic permeability, of the atmospheric oxygen, is disproved by the fact that there is no agreement between the chief magnetic variations and those of the temperature of the great mass of the atmosphere, though it is certain that there must be some effect due to this. The earth-current hypothesis is quite unable to explain one of the chief characteristics of these variations, that they are half as great again at periods of maximum as at those of minimum sunspot frequency. Sir George Airy has, moreover, been unable to detect any resemblance in form between the regular diurnal progress of the magnet and that of earth-currents. We seem, therefore, compelled to seek for the cause of the variations in the upper atmospheric regions, and we cannot imagine such a cause to exist in any other form than that of a system of electrical currents. That curents may, and actually do, exist at great heights is shown by the aurora, which is unquestionably an electric current, and manifests a close connection with the phenomena of terrestrial magnetism. The great increase of magnetic variation at epochs of maximum sunspot frequency can also be accounted for on this supposition: Prof. Stokes has remarked that an increase in the radiating power of the sun would probably imply not only an increase in general radiation, but a special and predominant increase in such actinic rays as are probably absorbed in the upper regions of the earth's atmosphere. These regions will, therefore, greedily absorb the new rays, their temperature will rise, and, as is known to be the case for gases, the electrical conductivity will be increased.

Thus, even if we imagine the general atmospheric current to remain constant, a greater proportion of it would be thrown at such times into those heated portions which had become good conductors, but it is also probable that the current itself would be increased. Assuming the existence of currents at great altitudes, the regularity and general characteristics of the diurnal variations would seem to point to a direct magnetic action of the currents rather than to any general induced change in the magnetic system of the earth, which, to produce the observed results, would have to be of a very artificial character. The diurnal variation of the declination, attaining a westerly maximum at 2 p.m. north of the equator, and an easterly maximum at the same time south of it, would suggest the existence of currents flowing northward and southward from the equator to the poles, attaining a maximum in each hemisphere about two hours after the sun had passed the meridian. To supply this flow we should probably have to assume the existence of vertical currents ascending from the equatorial regions of the earth. At this point Dr. Schuster has endeavoured to apply mathematical analysis to the subject. From the recorded observations at Greenwich, Lisbon, Hobarton, St. Helena, and the Cape, he has shown that the work done by a magnetic pole describing a closed path in a horizontal plane at those places is equal to the work done upon it, and consequently no part of the ascending current can be inclosed by the path. Hence the potential at those places obeys the law expressed by the equation—

$$\frac{d^2V}{dx^2} + \frac{d^2V}{dy^2} + \frac{d^2V}{dz^2} = 0.$$

From this Dr. Schuster has deduced two possible expressions for the potential, one referring to a system of currents above our heads, and the other to one beneath our feet. From the first of these expressions it follows that for latitudes greater than 45° the maximum of horizontal force should coincide with the minimum of vertical force, and *vice versâ*, and this is actually the case at Greenwich; while the opposite should hold if the influencing system were beneath us. For latitudes below 45° the reverse of the above should be the case, and the observations at Bombay, though less decided than those at Greenwich, would seem to point the same way. On the whole, then, it must be said that the results of the first attempt are very encouraging, and point to the supposition that the greater part of the disturbing cause lies outside the earth's surface. In a discussion that followed, Mr. Whipple remarked that recent observations in high latitudes seem to show that the aurora is not always at such a great height as is usually supposed. Prof. A. W. Rücker cited the well-known case when an observer saw what appeared to be a meteor fall into the sun, while simultaneously, or nearly so, there was recorded a magnetic disturbance on the earth, as showing a direct solar action. Mr. Whipple, however, stated that he had recently examined this point, and believes that the very slight notch in the record, many similar to which have occurred since, was of an accidental nature, and a mere coincidence. Prof. McLeod suggested that the earth-current theory might be tested by observations at the bottom of a mine, where, according to the theory, the disturbances should be reversed. Prof. Adams believed that there was nothing physically impossible in the existence of such currents as the author imagined.—On a relation between the critical temperatures of bodies, and their thermal expansions as liquids, by Prof. A. W. Rücker, F.R.S., and Prof. T. E. Thorpe, Ph.D., F.R.S. A paper by the authors bearing the above title was published in the *Journal* of the Chemical Society of London for April 1884. The substance of the paper was as follows. Prof. Mendeléeff has shown that the expansion of liquids under constant pressure between 0° C. and their boiling-points may be expressed by means of the very simple formula—

$$V_t = \frac{1}{1 - kt},$$

V_t being the volume at t° C. (that at 0° C. being unity), and k a quantity which differs for different substances, but which may for any one substance be considered invariable between 0° C. and the neighbourhood of the boiling-point. From this law the authors have obtained as a deduction the following expression for the critical temperature (T_c) of any liquid—

$$T_c = \frac{TV_t - 273}{a(V_t - 1)},$$

where V_t is the volume at t° C., T the absolute temperature, and a a quantity which is very nearly constant for all substances, and which was shown to be very nearly 2.—In a recent paper (*Ann. Ch. Ph*, March 1886) MM. A. Bartoli and E. Stracciati have discussed both of these formulæ, and have applied them to cases in a manner never intended by the authors. They have expanded Mendeléeff's formula into the series

$$V_t = 1 + kt + k^2t^2 + k^3t^3 + \ldots.$$

which is a geometrical progression, and they have objected to it that the results of Pierre, Kopp, Hirn, Thorpe, &c., do not give for the coefficients of t, t^2, t^3, quantities in geometrical progression. The results of these observers are given in the usual form—

$$V_t = 1 + at + bt^2 + ct^3 + \ldots.$$

but, owing to unavoidable errors of experiment, the constants c, d . . . of different observers differ very largely, and Mendeléeff's simple expression gives the results of all quite as accurately as the facts will allow. MM. Bartoli and Stracciati have then criticised the expression given by the authors, and have applied it to determine the critical temperature of water from its expansion to 200°, whereas the original expression is only given as applicable as far as the boiling-point. They have further recorded a number of critical temperatures calculated by the formula to tenths of a degree, for which the constant a would require to be known to ·025 per cent., whereas there is no reason for supposing it known to within 1 per cent. or more.

Zoological Society, April 6.—Prof. W. H. Flower, F.R.S., President, in the chair.—The Secretary exhibited, on behalf of Mr. J. B. Martin, F.Z.S., a large tusk of the Indian Elephant (*Elephas indicus*), about 6 feet long and weighing over 100 lbs., stated to have belonged to a "rogue elephant," with only one tusk, which had been killed at Goruckpore in 1836.—Mr. Sclater exhibited the heads and horns of two species of Antelopes obtained in the vicinity of Lamoo, East Africa, belonging respectively to *Strepsiceros imberbis* and *Damalis senegalensis*.—Mr. F. E. Beddard read a paper on some points in the anatomy of *Chauna chavaria*.—Prof. Flower communicated a paper, by Miss Agnes Crane, on a Brachiopod of the genus Atretia, from Port Stephen, Australia, described in manuscript by the late Dr. T. Davidson, and proposed to be called *Atretia brazieri*.—Mr. J. G. Goodchild, H.M. Geological Survey, read a paper on the disposition of the cubital coverts in birds. This communication described the principal modes of imbrication of the cubital coverts, as observed in healthy living birds of all the leading carinate forms, and pointed out that there is a certain correlation between particular styles of imbrication and various other characteristics connected with the pterolysis, the myology, the visceral anatomy, and osteology of the birds in question. The paper concluded with some observations upon the origin of the features described.—A communication was read from Dr. Günther, F.R.S., containing some further information on the melanotic variety of the South African Leopard which he had previously described.

Geological Society, April 7.—Prof. J. W. Judd, F.R.S., President, in the chair.—Edward George Aldridge, Charles Brownridge, James Dennant, Charles Lane, Prof. H. Carrill Lewis, and William Matthews were elected Fellows of the Society.—The following communications were read:—On glacial shell-beds in British Columbia, by G. W. Lamplugh. Communicated by Clement Reid, F.G.S. This paper was divided into two parts, relating respectively to Vancouver Island and the Fraser Valley. Having to spend nearly a month at the city of Victoria in 1884, the author had leisure for the investigation of the geological features of the district, but he expressed his regret that, at the time, he was unacquainted with the publications of Mr. Bauerman and Dr. Dawson on the subject. The most important shell-beds were disclosed in an excavation for a dry dock at Esquimault, V.I. Here a fissure in an igneous rock had been filled in by glacial beds. Shells were most numerous on the north side of the dock in Boulder-clay, associated with irregular sandy seams, the whole being softer than the general mass. The containing rock was not glaciated at this point. Leda, Nucula, Cardium, Tellina, Mya, and Saxicava are the principal genera. There was great difference in the state of preservation according to position; the shells below the water-line being remarkably fresh, while acidulous waters engendered by vegetable decay had attacked the upper portions. The author concludes that the whole mass of drift, including the shells, had been pushed up by ice in its passage southwards.

The general mode of occurrence was very similar to that at Bridlington. He further observed that the rocks were not striated in the first instance by these shelly clays, but he believed the glaciation to have taken place through the action of harder substances, and that afterwards a milder term set in, when an Arctic fauna established itself in the neighbourhood, after which fresh ice pushed the sea-bottom along with other accumulations into its present position. The shell-beds in the Fraser Valley are about 100 feet above sea-level. Three sections of glacial beds were given. The stratified clay in which the shells were found contains no pebbles, and, though somewhat disturbed, has evidently been deposited where it now occurs.—On a lower jaw of Machærodus from the "Forest-Bed," Kessingland, by James Backhouse, F.G.S.—A contribution to the history of the Cetacea of the Norfolk "Forest-Bed," by E. Tulley Newton, F.G.S.

EDINBURGH

Scottish Meteorological Society, March 29.—Half-yearly Meeting.—Mr. John Murray read the Council's report, which stated that since last July the only change that had taken place in the Society's stations was the loss of the station at Sandwick, in Orkney, and the establishment of a new station in the neighbourhood, at Swanbister. The three Members of Council who retired by rotation were Dr. J. B. Russell, Glasgow; Dr. J. D. Marwick, Town Clerk, Glasgow; and Prof. Alexander Dickson; and their re-election was recommended. In July last the membership of the Society was 698; it was now 712. In addition to the inspection of stations and the ordinary work of the Office, the Secretary had been engaged with the discussion of the Ben Nevis observations, and the work was now far advanced. Some time had also been given to the preparation of a fourth paper on the climate of the British Isles, dealing with the mean monthly distribution of the rainfall, based on the twenty years from 1866 to 1885. Mr. Omond was also engaged in the discussion of the Ben Nevis observations. During the summer and autumn the Observatory on the Ben had been utilised by Mr. H. N. Dickson for hygrometric observations; and Prof. Vernon-Harcourt and Mr. Harold Dickson, both of Oxford, had also spent some time at the Observatory in August conducting experiments and observations on the intensity of light in flames. The researches at the Scottish Marine Station were being prosecuted with vigour and success. Messrs. Mill and Morrison were engaged in collecting and tabulating all the observations which had been made around the coasts, and combining them with those made by the observers in connection with the Marine Station, the object being to obtain a more exact statement of the temperature conditions of the sea around the coast at different months of the year and at different depths. Observations had also been continued on the Firth of Forth by these gentlemen with very interesting results. It was shown by Mr. Mill on a former occasion that the winter condition of the Firth was one of uniformly-rising temperature from the river to the sea, and from the surface of the water to the bottom; while the summer condition was one of uniformly-falling temperature from river to sea, and from surface to bottom. The winter condition commenced in September 1885, nearly two months earlier than in 1884; the temperature of the water had been everywhere lower than in the winter of 1884-85, and at the present date there was no sign of the transition to the summer state. Two gentlemen in the north had been observing the temperature of the River Thurso at the mouth, and at a point twelve miles inland. The river, it is shown, responded rapidly to changes of temperature. During the greater part of the winter the water kept close to the freezing-point, though never actually freezing, except at the margin; while the sea had been uniformly from 10° to 5° warmer than the river, and its temperature had never been below 40°.—The Treasurer, Dr. Sanderson, stated that a member, who did not wish his name disclosed, had given 100*l*. to be distributed—50*l*. to Mr. Omond, 30*l*. to Mr. Rankin, and 20*l*. to Mr. Miller. The donation was "in acknowledgment of their services in the important work in which they were engaged, from an admirer of their indomitable pluck."—An interesting paper by Mr. Omond was read on the rainfall and winds at Ben Nevis Observatory. The winds, arranged in order of greatest frequency, are N., S.W., W., S.E., S., N.E., N.W., and E.,—the N.E. and E. winds being remarkably few in number. In their relation to the rainfall, the order of the winds for wetness is W., N.W., S.W., N., S., N.E., S.E., and E. The direction from which most rain came during 1885 was probably a little to the north of west, and the quantity diminishes as we go round the compass in both directions, until the driest point is reached a little to the south of east, the east winds having thus a very low figure both as regards frequency and the quantity of rain precipitated by them. Again, arranging the data for the amount of rainfall per 100 hours of each wind, the following is the order: N.W., W., S.W., S., N., N.E., S.E., and E.,—the E. and S.E. winds being very dry. With a falling barometer the average daily rainfall amounted to 0·587 inch, while with a rising barometer it was 0·483 inch.—The next paper was on rain-band observations on Ben Nevis, by Mr. Rankin, first assistant at the Observatory. The observations have been made on a scale of 0 to 5, and the mean results of the rainfall for three and twelve hours respectively after the observations showed that the rainfall increased steadily in amount with the figures of the scale. Grouping the observations according to season, it is shown that the subsequent rainfall was less with a higher, and greater with a lower, temperature. Very interesting observations were referred to, which were made in those states of the atmosphere, of no infrequent occurrence on the Ben, when aërial strata of great dryness and of complete saturation are superimposed on each other.—In a paper on the recent literature of the rain-band, Mr. H. R. Mill remarked that, although the spectroscope had been shown by many observers to give 80 per cent. of rain or of no rain occurring in a given time, results of great scientific value could only be expected when, as at Ben Nevis Observatory, it was combined with a complete series of hourly meteorological observations.—Mr. Buchan gave, in reference to the weather of the past winter, a short analysis of the temperature of Scotland during the past 122 years. During this long period the last 15 years showed the coldest 15 consecutive summers. Each of the 15 Junes was below its average temperature, except June 1873, which was 0°·2 above it. The mean of the Mays was 1°·6 under the average; the Junes 1°·2; and each of the other months from April to December from 0°·4 to 0°·9 under the average. The means for January, February, and March were above the average. During these 122 years there had occurred 38 hard winters, extending from two to six months each. Of these 38 winters 18 were followed by good summers and 20 by bad summers, and while of the 18 good summers 2 may be classed, in respect of the temperature, as very good, 8 of the 20 bad summers were very bad, and proved most disastrous to the grain crops.

PARIS

Academy of Sciences, April 19.—M. Jurien de la Gravière, President, in the chair.—Note on some new methods for determining directly the absolute value of refraction at various degrees of altitude, by M. Lœwy. After brief reference to the ordinary methods, including one recently proposed by the author himself, the paper goes on to explain a new process by means of which the refraction may be directly determined at all degrees of altitude,—an operation hitherto supposed to be impossible. It concludes with the description of a method for immediately ascertaining the effect of temperature and barometric pressure on refraction.—On the diurnal variation in direction and intensity of the magnetic force in the horizontal plane at Greenwich, as deduced from Sir G. B. Airy's observations made during the years 1841–76, by M. Faye. The author deals with the important series of diagrams appended by the Astronomer-Royal to the volume of Greenwich Observations for 1884, embodying the diurnal variations in horizontal direction and intensity of the terrestrial magnetic force for the thirty-six years ending in 1876 inclusive. As a general result it would appear that the magnetic curves, as exhibited in the 430 diagrams of Sir G. B. Airy's series, contract and expand periodically in direct agreement with the greater or less prevalence of the solar spots, and also with great regularity according to the seasons, the summer curves being invariably far greater than those of winter.—On the remains of fossil reptiles discovered by M. Fritsch in the Permian formations of Bohemia, by M. Albert Gaudry. These fossils, now collected in the Palæontological Museum of Prague, are grouped in twelve genera representing a whole series of quadrupeds of a comparatively high order, obtained in strata where, till lately, no animals had been found higher than the order of fishes. Compared with those of the Secondary epoch, all these Primary reptiles are of small size and imperfect development, inferior in these respects to the Actinoderm, Enchirosaurus, and Stereorachis found in the bituminous schists and other formations of corresponding age in France.—On the fluorescence of the earths provisionally named $Z\alpha$ and $Z\beta$, by M. Lecoq de Boisbaudran. In opposition to the views of Mr. Crookes, the author endeavours to show that these are really two distinct earths, not one substance identical with Mr. Crookes' Yt_2O_3, whose different fluorescent bands become diversely modified by the presence of foreign bodies.—On M. Marignac's earth $Y\alpha$, by M. Lecoq de Boisbaudran. At the author's suggestion, M. Marignac, discoverer of this rare earth, has at last definitely named it *gadolinium* (symbol Gd).—A second note on the origin of the electric discharge of thunder-clouds, by M. Daniel Colladon. A remarkable coincidence is pointed out between the author's observations and some electric phenomena observed at the same time near Shrewsbury, and reported in the *Monthly Meteorological Magazine* for September 1885.—On a mathematical essay by Prof. Battaglini, presented to the Academy by M. de Jonquières. This is a reprint from the *Giornale di Matematiche*, containing a demonstration of the theory of Cremona transformations, with some fresh developments of the same theory.—On the blight known as *taches nécrosées*, which attacks the peach-trees in the fruit gardens of Montreuil and other districts near Paris, by M. Prillieux. The cause of this local disease is traced to a parasite of the order Coryneum. Solutions of salts of copper or diluted sulphuric acid are proposed as remedies.—On the results of direct astronomic observation compared with those obtained from MM. Henry's photographic system, by M. Flammarion. The discrepancies between M. Wolf's chart and MM. Henry's photographs are attributed to errors of observation on the part of M. Wolf, and the author concludes that the photographic record is far more accurate and altogether more trustworthy than direct observation. The ten stars marked on M. Wolf's chart, but which do not appear on the photographs, are stated to have no existence in the firmament.—On the reduction of the Abelian integrals, by M. H. Poincaré.—Theorem on the binary forms, by M. d'Ocagne.—On the thermo-electric properties of the iodide of silver, by M. H. Le Chatelier.—Note on the vanadates of ammonia, by M. A. Ditte. The paper deals with neutral vanadate, bivanadate, yellow and red trivanadate, and other combinations formed by ammonia and vanadic acid.—Transformation of the protochloride of chromium into a sesquichloride: mechanism of the dissolution of the sesquichloride of anhydrous chromium, by M. Recoura.—On the acid fermentation of glucose, by M. Boutroux. The cause of fermentation is traced to a micrococcus greatly resembling the organism already described by the author under the name of *Micrococcus oblongus*.—A further survey of the vegetation of South Tonquin, by MM. Ed. Bureau and A. Franchet. The paper deals with a collection made in the hilly district south-west of the Song-Koi delta, by the Abbé Bon, and presented to the Paris Natural History Museum by the Abbé Hy. It comprises 857 species grouped in 124 families, and tends to confirm the impression that the flora of Tonquin has no special features, but forms a transition between those of China and India.—A new example of alternating generations in the fungus family (*Cronartium asclepiadeum* and *Peridermium Pini corticolum*), by M. Max. Cornu.—On the acrogenous development of the reproductive bodies in the fungus family, by J. de Seynes.—On the theory of earthquakes, by M. Stanislas Meunier. A number of fresh observations are advanced in support of the author's view that underground disturbances and eruptions are primarily due to the infiltration of surface-waters.—On the geology of East Tonquin, by M. E. Jourdy. From a protracted study of this region the author infers that in the interior the Carboniferous underlies the Triassic formation, while on the coast the Coal-Measures, here of infra-Liassic age, rest directly on the Carboniferous limestone in one of its folds.—On the disappearance of the nuclear chromatic elements and progressive appearance of the chromatic elements in the equatorial zone, by M. Ch. Degagny.—On the mycosic nature of tuberculosis, and on the bacillary evolution of its pathogenic fungus, *Microsporon furfur*, by MM. Duguet and J. Héricourt.

Berlin

Physiological Society, February 12.—Dr. Müllenhoff informed the Society that a treatise of the great astronomer Kepler had quite recently come under his notice, containing, under the title of "Neujahrsgeschenk, oder der sechsstrahlige Stern des Schnees" ("New Year's Present, or the Six-rayed Snow-Star"), a very clear and accurate description of the structure of the bee's cell. Kepler described the bee's cell as a rhombendodecahedron in which one trihedral pyramid was replaced by a straight terminal surface. The speaker further set forth the observations he had made on the way in which bees filled and preserved in their cells honey and pollen. The bee, which, according to the most recent determinations of Dr. Loew in the Botanical Gardens of Berlin, was able to force its way into most flowers, having first completely filled its capacious honey-stomach, crept into the cell, and, with its tongue, licked a small spot of the posterior uppermost edge many times, and on this spot, so moistened, it deposited a honey-drop. On this honey-drop other bees next discharged their honey till the whole cell was filled with the viscid liquid. Eight bees sufficed to fill one cell. Each deposited honey-mass got covered with a kind of pellicle that at a small spot was bitten through by the next succeeding bee, which then laid its honey at this opening, the honey penetrating into the interior. The filled cell was closed with a wax lid. The pollen brushed off the blossoms by the bees was, by admixture of a little honey or water, converted into a dough-like substance, and pressed into cells intended only for working bees till they were half filled. The rest of the cells were then filled with honey in the same manner as were the pure honey-cells. Finally these too were closed. When the cell was filled either with honey or with pollen-dough and honey, a drop of formic acid secreted from the poison-gland was infused through the lid by means of the sting. This formic acid, as had been proved by numerous experiments, preserved the honey, as also every other solution of sugar, from fermentation. Indeed formic acid in the proportion of 1/10 per cent. was altogether a very good preservative. Pollen, which was not covered with honey, got very soon mouldy.—Dr. Benda made further communications respecting spermatogenesis, first premising that the observations of his own which he communicated at the last meeting (*vide* NATURE, February 11, p. 360) had been published some months prior to that date by an English investigator, Herbert Brown. The similarity between the drawings of Mr. Brown and his own was striking. If he had thus been forestalled in the discovery of the new facts by his English contemporary, he had yet been able to observe a series of further details beyond the limit of what had hitherto been ascertained, several of which he communicated.—Dr. Gad had been engaged for a number of years in experiments on respiration, and both in those experiments carried out by himself and in those executed by his students he had obtained the same results. The problem was to establish whether the centres situated in the medulla oblongata and above it in the brain automatically discharged the movement of inspiration and expiration or only stimulated one group of respiratory muscles, actions which were to be characterised as normal excitations due to automatic activity and proceeding from the blood, not operating in a reflex manner. These centres were usually called automatic, but in the opinion of the speaker they would be more correctly described as autochthonous, seeing they were excited only at the particular place and spot, and not set in motion by any stimulus derived from the outside. To study the normal activity of these centres Dr. Gad examined the respiratory processes in the primary stage of dyspnœa, when the medulla oblongata was ill-supplied with air. The bad ventilation was brought about either by the animals having breathed the air so long that they were obliged to inhale air that was now grown vitiated, or having to breathe a mixture of nitrogen with less oxygen than was contained in atmospheric air, or a mixture of atmospheric air with carbonic acid; or the normal exchange of gas was restricted by tracheostenosis, or by heavy bleedings, or by the Kussmaul-Tenner experiment, in which, as was known, the flow of arterial blood to the brain was dammed off. In all the cases above enumerated, only augmented inspiration was always observed—never increased expiration. In the Kussmaul-Tenner experiment a lassitude of the inspiration set in very soon before the spasms had yet begun, a circumstance which called forth the appearance of an enhanced expiration. The method adopted in these experiments was considered by the speaker unobjectionable. Into the trachea of the rabbits there was fixed a cannula, which, by means of a double-direction tap, might be connected with the outer air or with very large gas repositories. The animal found itself in a small closed air-proof box communicating with a small, shallow box, the upper lid of which consisted of a movable mica plate, with recording lever. Each inspiration of the animal raised the lid, and consequently the recording lever, which marked on a rotating drum the curve of respiration. At each expiration the lid sank with the pen. Dr. Gad concluded from his experiments that, by bad ventilation of the respiratory centres automatic or autochthonous expiration could never be induced, but always inspiration alone. Dr. Gad further endeavoured to ascertain what was the limit of deficiency of oxygen and of carbonic acid admixture under which the first traces of dyspnœa showed themselves, and found that the animals were more sensitive to the excess of carbonic acid than to the deficiency of oxygen. An addition of 3 per cent. CO_2 was sufficient to excite dyspnœically augmented inspiration, while they could very well stand an air of 18 per cent. oxygen. The quantities of CO_2 which were mixed with the respiratory air were increased to 26 per cent. without the result being other than increased inspiration. Regarding the several series of experiments and their results, Dr. Gad would communicate a more special report at a subsequent meeting.

Meteorological Society, March 2.—Dr. Weinstein spoke on the earth's currents which were observable in the telegraph wires by the disturbances they caused in the message service, their intensity at times exceeding that of the batteries of eighty Daniell employed for telegraphing. In order to the observation of the earth's currents, two equal metal plates had since the time of Faraday been sunk into the ground and connected by a wire, in which a galvanometer was intercalated. The deviations of the galvanometer needle might be induced as well by an earth-current as by a current which arose from the contact of the earth-plates with the earth. In the latter case, however, the current would be very weak when the plates were at a great distance from each other. The case being, in point of fact, otherwise, however, the currents in question were accordingly earth-currents. The measurement of them was achieved by means of self-registering apparatus, either in the way of photography in England or mechanically in Germany; the earth-current was conducted through a coil, that, suspended in the interval between a rod magnet and a hollow cylinder magnet, was, under the oscillations of the current, drawn in or pushed out, and, by means of a lever, inscribed these movements on soot-blackened paper. The direction of the current in the body of the earth was found by observation of two circuits forming a right angle with each other. In Berlin one circuit proceeded eastwards towards Thorn, the other southwards towards Dresden. The observations made in Berlin showed a direction of the earth's current from north-east to south-west, while in England the direction went more from north to south with a slight deviation towards the east, and in France a direction from north to south with an inclination towards the west was observed. The earth-current showed a perfectly regular daily variation. In the night the earth-current is slight; from 8 o'clock in the morning it regularly increases, attains its maximum precisely at 12 noon, thence sinks rapidly till 4 p.m., whence it continues uniformly weak, not to revive till the following morning. A course precisely analogous to that of the earth-current was manifested by the earth's magnetism, the connection of which with the electricity of the earth attracted attention from the very beginning, when disturbances made themselves observable. To demonstrate with perfect precision the coincidence of the two phenomena it was necessary to take for the purpose of comparison not a single earth-magnetic element, but the earth's total magnetism. The earth's electricity and the earth's magnetism showed, moreover, in their regular daily course, their affinity, by the simultaneity with which their disturbances occurred. This simultaneity was so precise that in one case the distance between Berlin and Wilhelmshaven could be determined from the time when the disturbance of the earth's current made itself felt in Berlin and the time when the magnetic disturbance occurred in Wilhelmshaven. This simultaneity of disturbances at distant points of the earth pointed to a cosmical cause. Thus in August last year, at the very time when in Paris the emergence of an altogether unusual solar protuberance was observed, a magnetic disturbance was registered in Petersburg, and a disturbance of the earth's current in Berlin. The earth's current and the earth's magnetism showed further in common the periods of eleven years which coincided with those of the solar spots. In respect of the earth's current, this period could not indeed be demonstrated to a certainty, seeing that the regular observations made respecting it were yet of too recent date; but the regular course of the oscillations warranted the conclusion of a like period being drawn. A period of from two to five days in which the earth's current and the earth's magnetism showed in their oscillations alternately larger and smaller amplitudes had, in addition, been detected, although the explanation of the phenomenon was not yet forthcoming. With reference to the question which phenomenon was the primary, the earth's current or the earth's magnetism, opposite views were entertained. The earth's electricity was assuredly not strong enough to magnetise the body of the earth; but, on the other hand, against the assumption that the earth's currents were induced by the oscillations of the earth's magnetism an objection might be raised, namely, that in such a case the earth's currents would have to be proportional to the velocities of the oscillations of the earth's magnetism, and not to the oscillations themselves. This question can only be decided by further observations and by experiment. In a wide circle out of telegraph circuits the induction effects of the earth's magnetism might be studied and compared with the earth's currents. The speaker discussed the different theories of the earth's electricity set forth by Faraday, De la Rive, Lamont, Edlund, and the Brothers William and Werner Siemens, without declaring himself decidedly in favour of any of them. In conclusion he drew attention to the series of different jerks which showed themselves in the self-registering curve of the earth's currents on the occasion of every thunderstorm. A jerk of this description on the part of the pointer seemed to correspond with each lightning-flash.

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